"A RANDOMIZED CONTROLLED TRIAL TO EVALUATE CLINICAL PERFORMANCE OF PRE-FORMED ZIRCONIA CROWNS, CAD/CAM ZIRCONIA CROWNS AND PRE-FORMED RESIN POLYMER CROWNS IN PRIMARY MOLARS POST ENDODONTIC THERAPY"

Dissertation submitted to

SANTOSH UNIVERSITY, GHAZIABAD, NCR DELHI

In partial fulfillment of the requirement for the degree of

MASTER OF DENTAL SURGERY

in the Specialty of

PEDIATRIC AND PREVENTIVE DENTISTRY

Deemed to be University
(Established u/s 3 of the UGC Act, 1956)

By

Dr. RISHABH SOLANKI

Under the guidance of

Dr. NIDHI GUPTA

Professor and Head

DEPARTMENT OF PEDIATRIC AND PREVENTIVEDENTISTRY
SANTOSH DENTAL COLLEGE & HOSPITALS
GHAZIABAD- 201009, NCR DELHI, INDIA

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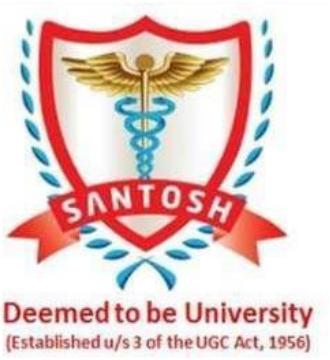

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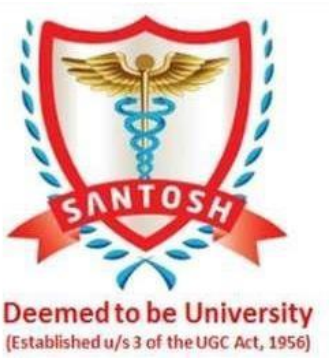

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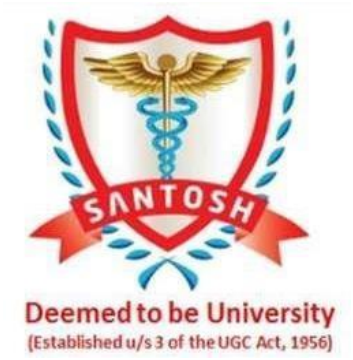

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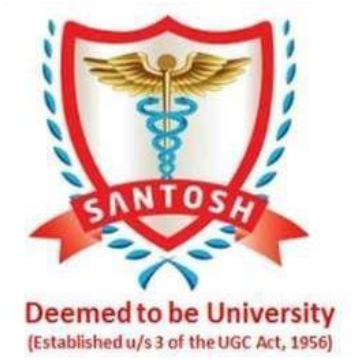
Date:

Place:

Prof. Dr. Akshay Bhargava
MDS (Prosthodontics)
AFFAAID, DICOI, DWCOI
DEAN
Santosh Dental College and Hospitals
Ghaziabad, NCR, Delhi



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Date:

Place:

Guide:

Dr. Nidhi Gupta

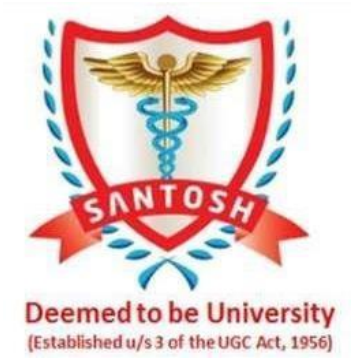
MDS

Professor and Head

Co-Guide:

Dr. Natasha Gambhir
MDS
Professor and Assistant Dean
Department of Pediatric and
Preventive Dentistry

Dr. Divya Singh
MDS
Reader
Department of Pediatric and
Preventive Dentistry



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Dr. Nidhi Gupta
MDS
Professor and Head
Department of Pediatric and Preventive Dentistry
Santosh Dental College & Hospitals
Ghaziabad, NCR Delhi

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Dedicated to all

My Beloved Teachers,

My Family

My Friends

For supporting me in all aspects which I have been through in these years

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INTRODUCTION

Dental caries remains a highly prevalent disease among young children. Once initiated, the caries process can progress rapidly, especially in the primary dentition. Among children worldwide, early childhood caries (ECC) is five times more common than asthma, and twenty times more common than juvenile diabetes.[1] ECC negatively impacts the quality of life for affected children and their families. According to a meta-analysis in 2023 the prevalence of ECC in India has been reported as 49.6% [1]. Dental caries can affect the primary dentition soon after eruption if adequate hygiene habits and healthy nutrition are not established at an early age [1].

Despite significant advancements in preventive dental care, including the widespread use of fluoride treatments, dental sealants, and educational campaigns promoting oral hygiene, dental caries remains the most prevalent oral health issue among children worldwide, particularly those under the age of three [2]. This enduring challenge is attributed to a combination of biological, behavioral, socioeconomic, and cultural factors that continue to hinder efforts to eradicate caries entirely [2].

Dietary practices, such as frequent consumption of sugary foods and beverages, prolonged bottle-feeding with sweetened liquids, and nighttime feeding habits, contribute to the persistence of caries in this age group [2]. Limited access to dental care, especially in low-income and rural areas, exacerbates the problem, as many families face financial and logistical barriers to obtaining professional dental services [3]. Additionally, caregivers often lack adequate knowledge of proper oral hygiene practices, leading to inconsistent brushing and flossing routines. The biological susceptibility of young children, including immature enamel, a developing oral microbiome, and in some cases, enamel hypoplasia, further predisposes them to carious lesions [3]. Moreover, disparities in public health resources and the unequal distribution of dental care infrastructure mean that children in underserved

communities are disproportionately affected. Despite global efforts to reduce the burden of caries through education and preventive strategies, the multifactorial nature of this disease, combined with environmental and social determinants of health, underscores the need for a more integrated and equitable approach to addressing the oral health needs of young children [2,3].

Aside from the pain and discomfort that untreated dental decay in the primary dentition causes, its consequences extend to significant financial burdens that often strain the resources of parents or guardians. The progression of dental caries, if left untreated, can result in complications such as pulpitis, abscess formation, or widespread oral infections, all of which necessitate more complex and costly interventions, such as pulpotomies, extractions or space maintainers [4].

These treatments, often requiring specialized pediatric dental expertise and multiple appointments, can be financially prohibitive for many families, especially those in low-income or underserved communities. Furthermore, the need for sedation or general anesthesia to manage young patients who are unable to cooperate during extensive procedures adds an additional layer of expense, which many guardians find challenging to afford. Beyond the direct costs, untreated decay can lead to indirect financial burdens, such as missed workdays for parents and transportation expenses to access specialized care [4]. The economic strain can delay treatment further, exacerbating the child's oral health issues and perpetuating a cycle of untreated disease. Furthermore, increased visits to hospital emergency rooms missed days from school and work to accommodate dental treatment, and increased risk of caries in the future permanent dentition [4].The care of decayed primary teeth is crucial due to their role in chewing, speaking, and functioning as natural space maintainers in the dental arch. Primary teeth are the corner stones of child's dentition, as their importance has already been

understood. Maintaining functional and esthetic aspects, contributing to keep normal articulation and securing the necessary space for the eruption of permanent teeth are some of the reasons why primary teeth need to be treated by practitioners [4].Stainless steel crowns are the most commonly used restorative options for repairing and preserving the remaining tissue of severely damaged and decayed teeth after the endodontic treatment has been done. They were introduced in pediatric dentistry in 1947, first described by Engel, and then popularized by Humphrey in 1950 [5]. Stainless steel crowns have outperformed other materials, such as amalgam and composite, in terms of durability and longevity for more than a half-century [5].

The biggest advantage of SS crowns is that it provides the benefits of low cost, reliability, and durability when interim full-coronal coverage is required [6]. Scientific evidence favors stainless steel crowns as restoration of choice in young children with high caries risk. Despite its many advantages, the use of stainless-steel crowns is not favored among some professionals because of certain disadvantages like unaesthetic appearance to the patient and longer chair side time [6]. An esthetic alternative to SSCs is Zirconia Crowns (ZCs). These are more widely adopted by the clinicians as ZCs overcome the disadvantages of SSCs [7]. These are more aesthetic to the patient and the chair side time is also reduced [6].

Zirconia crowns, which are also known as “ceramic steel,” have been introduced with reasonable esthetics and excellent mechanical properties for the restoration of permanent and primary teeth. They are contoured anatomically, free of metal, bio inert completely, white colored, and resistant to dental decay [7]. Zirconia has been successfully used in adult dentistry for over a decade, demonstrating its reliability and versatility. In recent years, this material has been adapted for pediatric dentistry, providing a more durable and aesthetically pleasing option for young patients. The growing popularity of all-ceramic restorations in pediatric dentistry has driven the development of zirconia crowns specifically designed for children.

Numerous brands, including NuSmile, Kinder Crowns, and Cheng Crowns, now offer specialized zirconia crowns that combine strength, biocompatibility, and natural-looking aesthetics, making them an increasingly preferred choice in pediatric restorative care [7].

Later on the application of CAD/CAM technology in dentistry provides innovative, state-of-art dental service, and contributes to the health and Quality of Living (QOL) of patients. It has more precision and provides easy workflow. The term CAD/CAM, which comes from machine-tool technology and stands for "Computer-Aided-Design / Computer- Aided-Manufacturing", designates the three-

dimensional planning of a work piece on the screen of a computer with subsequent automated production by a computer-controlled machine too [5].

Computer Aided Design - Computer Aided Manufacturing (CAD-CAM) is based on accurate prediction of dimensions of zirconia to compensate for shocking induced shrinkage. Though casting procedure has advanced over the past years, each of its steps could induce error in the final casting. Until 1988, indirect ceramic dental restorations were fabricated by conventional methods (sintering, casting and pressing) and neither was pore-free. Machining blocks of pore- free industrial quality ceramic can alternately produce pore-free restorations [5]. The tremendous advances in computers and robotics could also be applied to revolutionize dentistry and provide both precision and reduce time consumption [6].

Till date, only a few case series focusing on restoration of Primary molars with zirconia crowns have been published and reported clinical success [6]. There are no prospective clinical trials using a search of PubMed on the performance of ZCs on primary molars [6].

In the realm of aesthetic crowns for pediatric dentistry, preformed Bioflx crowns represent a recent innovation specifically designed to meet the aesthetic and functional needs of children

[8]. These crowns are the first of their kind, offering a unique combination of flexibility, durability, self-adaptability, and aesthetic appeal. By blending the advantageous properties of both stainless steel crowns (SSCs) and zirconia crowns, Bioflx crowns provide a versatile and effective solution for restoring primary teeth, addressing both functional requirements and cosmetic expectations in pediatric patients [8].

Bioflx crowns (Kids-e-Dental, LLP, Mumbai, India) are the first pediatric crowns designed to offer a unique combination of flexibility, durability, self-adaptability, and aesthetic appeal. These crowns are made from high-impact hybrid radiopaque polymer resin, a material widely used in medical equipment requiring superior strength, flexibility, and long-lasting durability[8].

Bioflx crowns have been successfully used on primary molars in various clinical scenarios, proving to be an effective and aesthetically pleasing alternative to the currently available tooth-colored preformed crowns [8].

Therefore, this study is planned to evaluate the clinical performance of Pre-formed zirconia crowns, CAD/CAM zirconia crowns and pre formed resin polymer crowns in primary molars post endodontic therapy.

AIM AND OBJECTIVES

AIM

To comparatively evaluate the clinical performance of pre-formed resin polymer crowns, preformed zirconia crowns and CAD-CAM crowns in mandibular molars over a follow up period of 12 months

OBJECTIVES

Primary Objective: -

- To evaluate and compare pre-formed zirconia crowns, CAD/CAM zirconia crowns and pre-formed resin polymer crowns post endodontic therapy in primary mandibular molars for marginal adaptation over a follow up period of 12 months

Secondary objective:-

- To evaluate and compare pre formed zirconia crowns, CAD/CAM zirconia crowns and pre-formed resin polymer crowns in primary molars for colour matching/staining over a follow up period of 12 months.
- To compare gingival health: Pre & Post cementation of pre formed zirconia, CAD/CAM zirconia crowns and pre-formed resin polymer crowns in primary molars over a follow up period of 12 months.
- To evaluate decementation of CAD/CAM zirconia crowns, pre-fabricated zirconia crowns and pre-formed resin polymer crowns over a follow up period of 12 months.
- To compare parental satisfaction post CAD/CAM zirconia crowns, pre-fabricated Zirconia crowns and pre-formed resin polymer crowns

REVIEW OF LITERATURE

1. **Almajed OS in 2024** [9] conducted a review to examine the evolution of dental crowns in pediatric dentistry, highlighting the transition from traditional materials such as stainless steel to aesthetic and biocompatible alternatives like zirconia, resin-based composites, and Bioflx crowns. The findings indicated that stainless steel crowns (SSCs) were valued for durability and cost-effectiveness, but they may cause hypersensitivity. Zirconia crowns are favored for biocompatibility, resistance, and aesthetics, although they are costlier and require more tooth reduction. Resin-based composite strip crowns offer a balance of aesthetics and function but have challenges in long-term stability. It was therefore concluded that traditional stainless-steel crowns to modern zirconia and resin-based and composites crowns, each type offers unique benefits in terms of aesthetics, durability, and biocompatibility. The recent introduction of Bioflx crowns, combining features of stainless steel and zirconia, highlights ongoing advancements, although further research is needed to fully understand their potential.
2. **Goswami M, Jangra B, Chauhan N, Khokhar A in 2024** [10] demonstrated the use of prefabricated Bioflx crowns to restore decayed primary teeth in pediatric patients and is a step towards giving functional restoration with esthetics in children. In comparison to ceramic zirconia crowns, which offer esthetic biocompatible full coverage for primary teeth, Bioflx crowns require less tooth reduction and are handled easily. Compared to zirconia crowns, they have a similar esthetic appearance. The use of zirconia crowns in primary teeth has a number of drawbacks, including the need for higher tooth reduction, the inability to be crimped, the expansion it causes, the wearing out of the tooth next to it, and the inability to be utilized in patients who have strong occlusal forces. It was reported that over a period of 6-month follow-up, Bioflx crowns demonstrated

promising results with good esthetics. Due to the esthetic appearance and convenience of adaptation, the BioFlx crowns can be preferred over zirconia crowns. It was therefore concluded that even though there are several esthetic crowns available in pediatric dentistry today, none of them can meet all the demands. BioFlx crowns could be an additional option for currently available cosmetic crowns, but long-term follow-up is still necessary for the determination of their durability, flexibility, and esthetic stability.

3. **Krug R et al in 2024** [11] assess the long-term clinical performance of ceramic in-/onlays (CIOs) and cast gold partial crowns (CGPCs) in posterior teeth in terms of success, survival, complications (biological, technical) and quality. A total of 296 restorations were assessed clinically and radiologically in healthy and endodontically treated teeth using modified United States Public Health Service (USPHS) criteria. The cumulative success rates of CIOs were 92.1% and of CGPCs 84.2% after mean service times of 14.5 years. The annual failure rates of total service times were 0.5% in teeth restored with CIO and 0.7% in teeth restored with CGPC. The cumulative survival rates of CIOs were 93.9% after a mean service time of 15.2 years and decreased to 91.7% after 23.5 years. The cumulative survival rates of CGPCs were 92.6% after a mean service time of 14.9 years and 91.8% after 23.5 years. Complications in CIOs were ceramic fracture (6.7%), secondary caries (4.7%), endodontic complication (2.7%) and tooth fracture (1.3%) compared to CGPCs with endodontic complication (8.8%), secondary caries (4.8%) and de-cementation (2.0%). Endodontically treated teeth restored with CIO or CGPC revealed significantly less often success compared with corresponding vital teeth ($p = .02$). CIOs and CGPCs revealed clinically and radio- graphically good and excellent qualities with 71.8% and 68% without any significant differences regarding type of restoration. Authors concluded that both CIOs and CGPCs achieved high survival rates up to 24.8 years when performed by super- vised undergraduate students.

The longevity of the restorations may benefit from the intraoral repair of accessible defects and, in case of pulp infection or necrosis, an adequate endodontic management

4. **Elhaddad EEH, Mohsen MMA & Mohamed DEE in 2024** [12] assessed the clinical performance of using indirect Milled composite or direct bulk-fill resin composite restorations for endo-treated teeth, as well as to measure the amount of wear on the occlusal tables of both restorations using a digital scanner. At all intervals, the majority of the cases in both groups had an alpha score. Some cases exhibited bravo scores in both groups at T6 and T12 regarding the colour match, marginal adaptation, marginal discoloration, and marginal integrity without statistically significant difference ($P > 0.05$). Direct nanohybrid bulk-fill resin composite showed a greater amount of wear without a statistically significant difference ($P > 0.05$). Extraoral measurement was significantly higher than intraoral measurement ($P < 0.001$). There was no significant reliability/agreement between both methods. It was concluded both milled composite and direct bulk-fill resin composite restorations in endodontically treated teeth demonstrated appropriate clinical performance and minimal wear over an 1-year follow-up period.

5. **Ali AAEM, Abo-ELsoud AAE & Helmy YS in 2024** [13] assessed and compared the fracture resistance of pulpotomized primary molars when rehabilitated with zirconia crowns and two distinct types of endocrowns, namely E-Max and Brilliant Crios. There was no statistically significant difference in fracture resistance of pulpotomized primary molars among lithium disilicate (E-Max) group (mean=1367.59N), Brilliant Crios group (mean=1349.73N) and zirconia group (mean=1240.82N). Authors concluded that endocrowns can be considered a promising restoration for pulpotomized primary molars.

6. **Rahate, I., Fulzele, P., and Thosar, N in 2023** [14] assessed the clinical performance as well as child and parental satisfaction for Bioflx, zirconia, and stainless steel crowns in pediatric patients between 3-7 year of age. Crowns were evaluated for recurrent caries, plaque accumulation, restoration failure, gingival status, opposing tooth wear, and clinicians' and parental satisfaction at zero, three, six, and 12 months. Results showed that the success rate of zirconia was 93.5% and for stainless steel full coverage restoration was 96.7%. It was further concluded that Bioflx crowns had better clinical as well as parental satisfaction compared to zirconia and stainless steel crowns. Therefore, the Bioflx crown was recommended as an alternative economical esthetic full-coronal restoration for primary teeth.

7. **Pei SL & Chen MH in 2023** [15] in 2023, Pei SL and Chen MH conducted a meta-analysis and systematic review comparing the periodontal health of primary teeth to review existing studies comparing stainless steel crowns and zirconia crowns. They screened 188 papers from various databases and selected five randomized controlled trials, including four comparisons on deciduous molars and one on deciduous incisors. 160 children were included, ranging in age from 3-9 years old. The quantitative analysis showed a significantly lower gingival index of zirconia crowns in the primary molar group and the primary incisor group. The plaque index between two crown treatments groups was -4.51, indicating less accumulation of plaque on zirconia crown. It was concluded that Zirconia crowns for deciduous teeth had its advantages for gingival health. Although stainless steel crowns were more likely to have plaque deposition and gingival inflammation, zirconia crowns relatively caused the opposite tooth wearing and chipping. Therefore, the comprehensive consideration is important to choose deciduous tooth crown.

8. **Abd Alraheam I, Al-Asmar A, Hasan N, Asoleihat F, and Alkayed A in 2023** [16] evaluated the success rate of cemented and adhesively bonded monolithic and partially layered zirconia and lithium disilicate crowns. Patients who had received zirconia or lithium disilicate crowns at the faculty practice were invited for clinical examination. The examiner used the Modified United States Public Health Service (MUSPHS) evaluation criteria to evaluate the crowns. The study found no significant differences between the groups in quality outcomes, except for marginal adaptation.where Adh-Zr achieved significantly higher scores compared to GIC-Zr and Adh-LD. Layered zirconia and lithium disilicate crowns have significantly higher quality outcomes in terms of anatomic form, marginal adaptation, and color match compared to monolithic zirconia and lithium disilicate crowns. It was therefore concluded that conventionally cemented zirconia and adhesively bonded zirconia and lithium disilicate crowns are reliable treatment options with high short-term success rates. Clinical studies with longer follow up times are needed to investigate their long-term success rates.

9. **Sinha T et al in 2023** [17] visually assessed the color of maxillary anterior teeth in male and female subjects from three different age groups in Uttar Pradesh, India. Group 1 included participants aged 18–30 years, Group 2 included those aged 31–40 years, and Group 3 comprised individuals aged 41–50 years. It was reported that according to the Vitapan Classic shade guide, 26% of Group I participants matched the first Hue group (A1), 14% of Group II participants matched the first Hue group (A3), and 20% of Group III participants matched the second Hue group (B2). Master shade guide for Vita 3D 26% of Group I participants matched with the secondvalue group (2M2), 18% of Group II participants matched with the third value group (3L 1.5), and 24.5% of Group III participants matched with the third value group (3M2). Eighty percent of people who were matched to Alpha scored for crowns made using the Vita 3D Master shade guide,

while 94.1% of people who were matched to Charlie scored for crowns made using the Vitapan Classic shade guide in a comparison of the two shade guides. The authors concluded that the majority of the shades obtained from the Vita 3D master shade guide were found to be 1M1 and 2M1 in the younger patients, 2M1 and 2M2 in the second age group, and 3L 1.5, 3M2 in the older age group. In contrast, the Vitapan Classic shade guide revealed A1, A2, A3, B2, C1, D2, and D3 as the predominant shades.

10. **Rauch A et al in 2023** [18] evaluated the clinical performance of chairside fabricated tooth-supported posterior single crowns from lithium disilicate ceramic. Thirty-four crowns were inserted between 2006 and 2007 and again evaluated after 15 years. Results revealed that six failures occurred (1 technical/5 biological) resulting in a survival rate of 80.1%. The success rate was 64.2%. The roughness of the crowns increased ($p = 0.021$) and the majority of adhesive gaps were discoloured ($p = 0.001$) in comparison to baseline. The colour, tooth, and crown integrity remained stable over the follow-up period ($p \geq 0.317$). It was therefore concluded that the fabrication of tooth-supported lithium disilicate crowns using a chairside approach yielded acceptable long-term survival and success rates. Due to discoloration, the long-term use of dual-cure self-adhesive resin cements might result in unpleasing aesthetic results.
11. **Alamoudi RA, Walia T & Debaybo D in 2023** [19] evaluated the clinical success rate of NuSmile pediatric Zirconia crowns in both primary anterior and posterior teeth up to 2 years in terms of gingival health, levels of plaque, restoration failure, and marginal integrity. Results revealed that Gingival and plaque index of the teeth restored with NuSmile Zirconia crowns (test tooth) compared with adjacent and antagonist teeth (control tooth) showed no statistically significant difference at all time intervals. Out of the 172 NuSmile Zirconia incisor crowns placed, only 82 teeth survived at the end of 2 years and the majority of the crowns completely lost the Zirconia crown. Authors

concluded Zirconia paediatric crowns preserve and maintain gingival health and have long term survival rates with good retention and marginal integrity, indirectly preventing secondary caries. Hence, Zirconia paediatric crowns are a well-suited restoration of choice for primary teeth rehabilitation

12. **Oz E, Kırzıoglu Z & Kale C in 2023** [20] evaluated the clinical and radiographic success of the Hall technique (HT) and atraumatic restorative treatment (ART) restorations using high-viscosity glass-ionomer cement for the management of occlusal carious lesions in primary molars. Thirty of 40 (75%) participants returned for 18 months of follow-up. In the clinical evaluations of teeth that were treated with HT, the patients did not have complaints of pain or other symptoms, all crowns remained in the oral cavity, the gums were healthy, and the teeth were functional in all evaluations. At the end of the 18-month follow-up, the surface texture and marginal integrity criteria of ART restorations were recorded as 26.7% and 33.3%, respectively. In the radiographic evaluation of 30 patients treated with ART and HT, all restorations were considered successful. Authors concluded that 18-month clinical and radiographic results after treatments applied to single-surface cavities in anxious children showed that both treatment methods were successful.
13. **Park S et al in 2023** [21] evaluated the mechanical properties of two types of 3D-printed resin crowns in terms of strength and surface characteristics. Polymer resins used for temporary crowns (TCs) and temporary flexible dentures (TFDs) were tested. The crown surface was evaluated using scanning electron microscopy. The average strength did not differ between the types of crowns. The differences between the dynamic and static fracture loads were insignificant. In the TC group, thicker crowns showed lower strength both under static and dynamic loads. After thermomechanical loading, microcracks and dropouts of macro-fillers were detected on the surface of all types of

resin crowns. The deposition of abraded debris occurred more in the TFD group. It was concluded that considering the maximum bite force of children and adolescents, 3D-printed resin crowns have acceptable strength when considering a treatment option for pediatric patients. Based on the cyclic loading test, crowns fabricated using TFD resin were more advantageous.

14. **Verma RK et al in 2023** [22] examined parental satisfaction over one-year period in children aged three to five who received either Strip Crowns or Preformed Primary anterior Zirconia Crowns. Both restoration options received positive feedback from parents in relation to the effect of crown type by considering factors such as dental health and the frequency of the child smiling. A five-point Likert-type scale was used, with 1 indicating "Highly Displeased" and 5 indicating "Highly Satisfied," similar to the scales used in other research. Additionally, parents were asked whether they would recommend the same treatment to others who need similar rehabilitation, with responses recorded as "Yes" or "No". The parents who expressed less pleasure with the strip crowns longevity and the color of zirconia crowns still acknowledged their functional benefits and aesthetic improvements compared to other restorative materials. In conclusion, prefabricated primary anterior zirconia crowns were more popular with parents than strip crowns. All other criteria were about equally well-liked by parents, with the exception of longevity, which was more common for zirconia crowns
15. **Varghese E et al in 2023** [23] assessed the microleakage of stainless-steel crowns along with pedo jacket crowns following cementation with different luting cements. Stainless steel crowns subject to cementation with RelyX luting cement exhibited the lowest microleakage (0.88 ± 0.78) versus self-cure RMGI cement (0.94 ± 0.78). There was no statistically significant difference found between the groups. Pedo Jacket crowns subject to cementation with RelyX luting cement exhibited the lowest microleakage

(0.96. ± 0.32) while self-cure RMGI cement (1.83 ± 0.16) depicted the maximum microleakage. There was an extremely statistically noteworthy dissimilarity noted among the groups. The current research concluded that Pedo Jacket crowns subjected to cementation with RelyX luting cement can be regarded as an esthetically pleasing restorative alternative for numerous young patients. Applying RelyX luting cement to Pedo Jacket crowns provides a strong bolstering by composite materials that ensures the success of the therapy provided.

16. **Prabhu D et al in 2022** [24] conducted a study to clinically evaluate the performance of preformed SSCs and custom-made zirconia crowns in primary molars. To elicit parental and patient satisfaction with respect to preformed SSCs and custom-made zirconia crowns and to radiographically compare the interproximal bone height for 1 year. After 1 year evaluation of custom-made zirconia crowns and preformed SSCs in primary molars, it was shown that both SSC and zirconia crowns showed good gingival scores but zirconia crown was better than SSC in improving the gingival health. SSCs showed better results with respect to the opposing tooth wear and marginal adaptability. Parents as well as patients preferred a tooth-colored crown as a treatment option. It was therefore concluded that custom-made zirconia crowns are comparable to the preformed SSCs and they show better gingival scores and excellent color match.

17. **Rinke S et al in 2022** [25] evaluated the 5-year performance of chairside-fabricated zirconia-reinforced lithium silicate (ZLS)-ceramic partial crowns. Forty five patients participated in the 5-year follow-up study who were treated with 61 chairside-fabricated ZLS. Restorations were fabricated with reduced minimum material thicknesses (MMT), deviating from the manufacturer's recommendations: group 1 had MMT ranging from 0.5–0.74 mm (n = 31), while group 2 had MMT between 0.75–1.0 mm (n = 30). For cementation, either a self-adhesive cement (SAC) or a total-etch technique with

composite cement (TEC) was used. Statistical evaluation was performed using time-to-event analysis (Kaplan–Meier). Possible covariates influencing survival (SVR) and success rates (SCR), which were analyzed using a Cox regression model, included MMT, restoration position (premolar/molar), and cementation technique. Results revealed that the success rate for partial crowns placed on premolars was 100% and 69%) for molar restorations. Re-cementation was required in 4 restorations with SAC. Restorations in group 2 showed a significantly reduced risk of material fracture hazard ratio compared with the restorations in group 1. Molar partial crowns showed an increased risk for a clinical intervention compared to premolar restorations. It was therefore concluded that material thickness and position of the restoration are risk factors influencing the survival and success rate of ZLS-ceramic partial crowns.

18. **Hardan L et al in 2022** [26] systematically reviewed the literature to evaluate the clinical outcomes of direct or indirect restorations for treating tooth wear. From this systematic review, clinical proof was evaluated to compare the direct and indirect materials used in the treatment of worn teeth. A comprehensive literature search was conducted across the PubMed MedLine, Scopus, ISI Web of Science, Scielo, and EMBASE databases up to April 29, 2022. Clinical studies assessing the performance of direct and indirect restorations for tooth wear, with a minimum follow-up of six months, were included. A total of 2,776 records were retrieved from the search, and after full-text review, 16 studies were selected for qualitative analysis. Due to the high heterogeneity of the studies included a meta-analysis was not conducted. All studies involved the rehabilitation of anterior and posterior teeth with significant wear, using both direct and indirect restorations, with follow-up periods up to 10 years. The restoration materials used included ceramic metal crowns, full gold crowns, lithium disilicate ceramic, zirconia, polymer-infiltrated ceramic networks, and resin composites. Most reports

focused on assessing restoration survival rates and clinical features, following the United States Public Health Service (USPHS) Evaluation System criteria. The findings were inconsistent regarding which type of restoration demonstrated better clinical performance. Based on the current literature, there is no clear evidence to support the superiority of any particular restoration technique for ensuring optimal clinical outcomes in treating tooth wear. Authors concluded that there is no evidence in the superiority of any restoration technique to ensure the highest clinical performance for treating tooth wear. Further well designed randomized clinical trials are required in order to establish an optimal restoration technique protocol for the restoration of tooth wear.

19. **Elheeny AAH & Abdelmotelb MA in 2022** [27] compared oral health–related quality of Life (OHRQOL) of preschool children's anterior teeth restored with prefabricated zirconia crowns (ZC) versus resin-bonded composite strip crown (RCSC). After 12 months, the USPHS parameters of the ZC were significantly superior compared to the RCSC. Overall ECOHIS mean scores in the ZC group were significantly lower than that of the RCSC group at T and T ($p < 0.001$). Remarkable enhancement of the OHRQOL at the follow-ups with a large effect size ($r < 0.8$) was observed. Restoration type, retention, baseline OHRQOL, and color had a significant impact on the overall OHRQOL at 12 months. It was concluded that Preschool children OHRQOL treated with ZC were significantly better than those who received RCSC.
20. **Murali G et al in 2022** [28] clinically evaluated and compared the performance of posterior pediatric zirconia crowns with stainless steel crowns. Twenty-nine children were selected and were given 70 preformed crowns. Crowns were evaluated for retention, marginal integrity, opposing tooth wear, plaque accumulation, gingival inflammation, and proximal contact at 3, 6, 9, and 12th month. At the end of follow-up

period overall success rate of zirconia crown was 93.5% and that of stainless-steel crown was 96.7%. Statistical analysis showed no difference between the groups. It was concluded that posterior preformed zirconia and stainless- steel crowns showed good clinical performance. Preformed zirconia crowns can be an option for posterior full coronal restoration when aesthetics is of prime concern for the parent and child.

21. **Bin-Shuwaish MS et al in 2021** [29] compared the adaptation, contour, contacts, and shade matching of different government and commercial dental LABs in the fabrication of porcelain fused to metal (PFM) crowns. Marginal adaptation, contour, proximal contacts, and shade matching were evaluated. Evaluation of the crowns' quality was performed following modified USPHS/FDI criteria. Visual and colorimeter assessments were employed to evaluate shade matching. It was reported that the quality of marginal adaptation of crowns was good in 81.25%, however the quality of contours, contacts, and shade matching was compromised in 43.75%, 59.38%, and 39% of all LABs, respectively. Visual and colorimeter shade matching was acceptable in 62.5% and 80% of LABs in the cervical third and middle third regions of crowns, respectively, however in the incisal third the shade matching was unacceptable in nearly 60% of LABs. It was therefore concluded the proximal contacts and marginal adaptation of PFM crowns fabricated by commercial and government managed LABs were comparable. However, contours and color matching of PFM crowns produced by commercial LABs were significantly better compared to government LABs

22. **Sadeqi HA, Baig MR & Al-Shammari M in 2021** [30] evaluated the accuracy of fit of CAD/CAM complete coverage monolithic ZLS crowns and compare with monolithic Zi crowns, in terms of marginal gap (MG), absolute marginal discrepancies (AMD), and internal gap (IG) widths between the crowns and the master die (conforming to a mandibular molar tooth preparation), by using nano CT-based analysis. Secondly, the

study aimed to assess the fracture resistance of Zi crowns compared to the ZLS crowns, with and without mechanical aging (cyclic loading). Results showed no significant differences between Zi and ZLS crowns ($p > 0.05$); for both internal and marginal gaps, however, there were significant differences in AMD ($p < 0.005$). Independent samples Mann-Whitney U and Kruskal-Wallis tests revealed significant differences between the two materials, Zi and ZLS, regardless of fatigue loading, and for the individual material groups based on aging ($\alpha = 0.05$). Multiple comparisons using Bonferroni post-hoc analysis showed significant differences between Zi and ZLS material groups, with or without aging. Authors concluded that as regards fracture resistance, both materials survived the normal range of masticatory forces, but the Zi crowns demonstrated greater resistance to fracture. The monolithic Zi and ZLS crowns seem suitable for clinical application, based on the fit and fracture strength values obtained.

23. **Oguz EI, Bezgin T, Orhan AI & Orhan K in 2021** [31] aimed at comparing the adaptation of two types of esthetic paediatric crowns, the prefabricated fiberglass and custom-made resin-ceramic crowns, for primary teeth. Results showed significantly lower overall and location-based gap measurements than Figaro crowns regardless of tooth number ($p < 0.05$). For all groups, mean marginal discrepancies were lower than occlusal measurements ($p < 0.05$). Both crown types showed higher marginal gaps for molar teeth than for canine and central incisors with no significant difference between them ($p > 0.05$). CAD/CAM-fabricated crowns showed better marginal and internal adaptation than prefabricated Figaro crowns.
24. **Hanafi L, Altinawi M & Comisi JC in 2021** [32] demonstrated the effectiveness of locally manufactured zirconia crowns created via Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM) system and compare these locally milled zirconia crowns to commercially available zirconia crowns, assess the integrity of the gingiva

around them after application to restore primary teeth. This study showed that CCZC did not cause gingival changes after crown application in clinical tis- sue appearance, bleeding, and gingival recession. Reduced plaque accumulation was observed during follow-up periods. Finally, there was no statistically significant difference between CCZC and NZC, according to this study. It was concluded that CCZCs are a convenient and economical option to achieve aesthetic, healthy, and functional aspects during restoring primary teeth**.**

25. **Mathew MG, Roopa KB, Soni AJ, Khan MM & Kauser A in 2020** [33] evaluated and compared the clinical success, parental satisfaction, and child satisfaction of stainless steel and zirconia crowns in primary molars. Clinical success for stainless steel crowns and zirconia crowns were similar with no statistical difference between them. Zirconia accumulated less plaque than stainless steel crowns (P = 0.047). The parental satisfaction was high with both crowns. A highly significant statistical difference existed between the 2 groups in relation to the acceptance of colour (P < 0.001) and child's satisfaction (P < 0.001). It was concluded that Zirconia can be considered as an esthetic alternative in the future.

26. **Alaki SM, Abdulhadi BS, AbdElBaki MA, Alamoudi NM in 2020** [34] aimed at comparing prefabricated primary zirconia with resin composite strip crowns on primary maxillary central and lateral incisors with regards to gingival health, plaque accumulation, recurrent caries, restoration failure, and opposing teeth wear over a period of 3, 6 and 12 months. A total of 120 teeth were treated; 60 with zirconia and 60 with strip crowns. Zirconia crowns showed significantly less gingival bleeding at the 3- and 6-months follow up periods, less plaque accumulation at all follow up visits ($p < 0.001$), no restoration failure ($p < 0.001$), but more wear to opposing teeth ($p < 0.02$). No significant difference was found between the two crowns with regards to recurrent

caries ($p < 0.135$). it was therefore concluded that overtime teeth covered with zirconia crowns show better gingival health and less bleeding, plaque accumulation as well as less loss of material. On the other hand, zirconia can cause more loss of opposing tooth structure.

27. **Nischal M, Gupta T, Mehra M, Sadana G in 2020** [35] evaluated the surface texture, anatomical form, marginal integrity, marginal discoloration, and secondary caries of three different types of crowns in primary anterior teeth at different time intervals of 3, 6, and 9 months. Total of 45 primary maxillary incisors were randomly selected and divided into three groups of 15 each: Group I—strip crowns, Group II—zirconia crown and Group III—luxa crown. All the full-coronal restorations were evaluated at 3, 6 and 9 months. Statistically nonsignificant difference was observed for most of the parameters except marginal integrity and secondary caries. Resin strip crowns showed maximum cases with distorted marginal integrity and secondary caries. Authors concluded that zirconia crown performed best among the three full-coronal restorations. Luxa crown per- formed similar to zirconia crown. It can be used as an alternative economical esthetic full-coronal restoration for primary maxillary anterior incisors
28. **Ajayakumar LP, Chowdhary N, Reddy VR & Chowdhary R in 2020** [36] analyzed the suitability of the zirconia crowns for restoration of damaged primary teeth in children. It was reported that Zirconia crowns have been proved with better results than other crowns in terms of gingival and periodontal health, esthetics, and crown fractures. However, the quantity of tooth preparation and the wear of antagonist tooth are reported to be more in the case of zirconia crowns. Future randomized control studies should be carried out in primary teeth due to less number of randomized studies on this topic
29. **Bamdadian Z, Pasdar N, Alhavaz A, Ghasemi S & Bijani A in 2019** [37] compared the physical and mechanical properties of different commercial brands of these crowns. The

highest rate of microhardness, compressive and Fatigue strength of the crowns were made by Nu Smile > 3M > Kids Crown > KTR respectively. The highest rate of corrosion potential in corrosion and Galvanic corrosion tests was in KTR > Kids crowns > 3M > Nu smile respectively. The order of crown wear was KTR > Kids Crown > 3M > Nu Smile respectively. The highest amount of nickel element was found in the Nu Smile crown and the highest amount of chrome in the 3M crown with a significant difference with others ($p < 0.001$). The KTR and Kids crowns lacked molybdenum. The results showed that Nu Smile crown has better physical and mechanical properties than other evaluated crowns in this study.

30. **Sevekar S et al in 2019** [38] reported the clinical steps in the rehabilitation of grossly carious primary maxillary incisors and mandibular primary molar in young children respectively using primary zirconia crowns. It was reported that a zirconia crown over an open-faced SSC omits the additional preparation of the labial surface. Moreover, the esthetic appearance of zirconia was far more superior to the open-faced SSC. We observed that zirconia provides superior gingival tissue adaptation. Unlike CSC and SSC, the smooth polished surface of zirconia prevents staining and plaque accumulation. An equilibrium of strength, precision, and translucency permits zirconium restorations to accommodate various clinical situations. It was therefore concluded by the authors that zirconia crowns are simple and effective means in the rehabilitation of grossly carious, badly broken down, and fractured primary anterior and posterior teeth. They have shown unparalleled advantages of improved esthetics and microstructure.

31. **Skjold A, Schriwer C, Øilo M in 2019** [39] analyzed the effect of different preparation and crown margin designs on load at fracture for bilayer zirconia crowns. The crowns were examined at 10× magnification in an optical stereomicroscope (Leica M205 C;

Leica Microsystems, Wetzlar, Germany) for signs of marginal defects. All defects or irregularities were registered and graded on a scale of 1–5, according to severity, on a Likert scale. The crowns were cemented to epoxy models of the preparations with zinc phosphate oxide cement. The cement was chosen to minimize the bonding effect of the cement. It was reported that the crowns on a chamfer preparation fractured at higher loads compared with crowns on a slice preparation. An additional cervical collar increased load at fracture for hard-machined crowns. It was further concluded by the authors that zirconia crowns made for a chamfer preparation fracture at significantly higher loads than similar crowns made for a slice preparation design. Both preparation designs resulted in crowns that fractured at loads above normal mastication forces. A slice preparation with a modified cervical collar crown design may increase both technical and biological success. The veneering process decreases the fracture resistance significantly, just as reduced wall thickness reduces load at fracture.

32. **Lopez-Cazaux S, Aiem E, Velly AM & Muller-Bolla M in 2019** [40] assessed the effectiveness of ZCs compared with SSCs. With sustained poor oral health in most developed communities, and greater importance being given to esthetic factors, the results of the present RCT will inform clinicians regarding the selection of clinical treatment options for severe dental decay which affect most children. The re- sults will help them explain to the parents the advantages and disadvantages of the two possible solutions. The results will allow for advancement in the recommendations, and will be beneficial for the patient, the practitioner, and the public healthcare system.

33. **Taran PK, Kaya MS. A in 2018** [41] compared the periodontal health and clinical success of restoring primary molars with a prefabricated stainless steel crown (SSC) or zirconia crown (ZC). Fifty-two teeth were evaluated in 13 children for 12 months. The OHI-S levels were not different at the follow-ups. Teeth restored with ZCs showed

lower GI and PI scores than those restored with SSCs, even among controls. All SSCs were retained after 12 months, while two of the ZCs de-cemented. Minor staining in one ZC and a fracture on the surface of another ZC were observed. It was concluded that the gingival health and plaque accumulation performance of zirconia crowns were better than those of stainless steel crowns and controls. SSCs are highly retentive and viable restorative options, although they were associated with a decline in gingival health.

34. **Konstantinidis I, Trikka D, Gasparatos S, Mitsias ME in 2018** [42] examined the clinical performance of posterior monolithic single crowns in terms of failure or complications and the secondary aim was to assess the quality of these restorations according to the United States Public Health Service (USPHS) criteria. 65 patients who needed posterior crowns were restored with monolithic zirconia crowns. All the restorations were evaluated 6 and 12 months after their cementation. The modified United States Public Health Service (USPHS) criteria and periodontal parameters were applied for the clinical evaluation of the crowns. No fracture of the restorations was recorded. The overall success rate was 98.5%. The clinical quality of all crowns was acceptable except for the marginal discoloration of one crown at the 6 and 12 months follow-up examination. It was therefore concluded that no fracture of single-tooth monolithic crowns occurred and the success rate was high. Monolithic zirconia restorations fabricated is a viable option for the restoration of single posterior teeth.

35. **Al Shobber MZ & Alkhadra TA in 2017** [43] investigated and compared fracture resistance of four commercially available esthetic crowns. Zirconia crowns had the highest fracture resistance compared to preveneered crowns ($p < 0.05$). No significant difference was seen between NuSmile ZR Zirconia and Cheng Crowns zirconia nor between NuSmile primary Preveenered and Preveneered Cheng Crowns. It was

concluded that Zirconia crowns showed the highest fracture resistance with NuSmile zirconia crowns to being able to resist fracture even under intense pressure of load compared to Cheng Crowns zirconia.

36. **Samer MS et al (2017)** [44] investigated the clinical performance of LD single crowns and to determine the predictors of satisfaction in patients restored with LD all-ceramic crowns among a Malaysian population. Clinical outcomes were assessed in 47 patients with 88 LD crowns using modified United States Public Health Service (USPHS) evaluation criteria and survival rates. The questionnaire for predictors included 3 aspects: (a) sociodemographic characteristics, (b) oral health habits (tooth brushing frequency, flossing frequency, and dental visits), and (c) satisfaction of the restorations (aesthetics, function, fit, cleanability, and chewing ability of the crowns, and overall satisfaction). The age of crowns was 34.7 ± 9.7 months. The survival rate was 96.6% at 35.9 ± 9.2 months. There was a significant association between successful crown function and oral hygiene measures: tooth brushing ($p< 0.001$), dental visits ($p = 0.006$), and flossing ($p = 0.009$). A strong negative correlation was observed between aesthetic satisfaction and chewing ability with crown age. The linear regression model was significant for all predictors ($p < 0.05$) except overall satisfaction ($p > 0.05$). It was concluded that The LD crowns had long survival rates of 96.6% up to 35.9 ± 9.2 months and provided satisfactory clinical performance (low risk of failure). Oral hygiene habits such as brushing, flossing, and regular dental visits influenced patient satisfaction with LD crowns.

37. **Mohammadzadeh Z, Parisay I, Mehrabkhani M, Madani AS, Mazhari F in 2016** [45] evaluated the clinical performance of tooth-coloured fibre-reinforced composite (FRC) crowns in pulp-treated second primary mandibular teeth. Modified United States Public Health Service criteria were used to evaluate marginal integrity, marginal discoloration,

and secondary caries in FRC crowns at intervals of 3, 6 and 12 months. Retention rate and gingival health were also compared between the two groups. It was reported that intact marginal integrity in FRC crowns at 3, 6, and 12 months were 93.2%, 94.8%, and 94.2%, respectively. Marginal discoloration and secondary caries were not found at any of the FRC crowns. The retention rates of the FRC crowns were 100%, 98.3%, and 89.7% at 3, 6 and 12 months, respectively, whereas all the SSCs were found to be present and intact after 12 months (P = 0.016). There was no statistically significant difference between the two groups in gingival health. According to the results of this study, it seems that when esthetics is a concern, in cooperative patients with good oral hygiene, FRC crowns can be considered as a valuable procedure.

38. **Innes NP et al in 2015** [46] evaluated the clinical effectiveness and safety of all types of preformed crowns for restoring primary teeth compared with conventional filling materials (such as amalgam, composite, glass ionomer, resin modified glass ionomer and compomers), other types of crowns or methods of crown placement, non-restorative caries treatment or no treatment. The final study compared two different types of crowns: PMCs versus aesthetic stainless-steel crowns with white veneers. No RCT evidence was found that compared different methods of fitting preformed metal crowns. It was therefore concluded that crowns placed on primary molar teeth with carious lesions, or following pulp treatment, are likely to reduce the risk of major failure or pain in the long term compared to fillings. Crowns fitted using the Hall Technique may reduce discomfort at the time of treatment compared to fillings. The amount and quality of evidence for crowns compared to non-restorative caries, and for metal compared with aesthetic crowns, is very low. There are no RCTs comparing crowns fitted conventionally versus using the Hall Technique.

39. **Pomarico L, Neves BG, Maia LC & Primo LG in 2011** [47] evaluated longitudinally, the clinical performance of restorations in deciduous molars with high caries activity using 2 different techniques, resin composite, and biologic restoration. For evaluating restoration techniques, transillumination was shown to be advantageous due to its low cost and ease of transportation. This technique is not only well established as an effective in diagnosing carious lesions, but it also fulfills the objectives proposed by the present study, namely, detecting microleakage in restored deciduous teeth. Despite poor biofilm control and consequent coronal destruction of some deciduous molars, the restorative techniques used in the present study were shown to be efficient after several years of follow up. A higher success rate in sealing the interface tooth-restoration was obtained by the bio- logic bonding method.

40. **Akbar JH, Omar R, AL-Tarakmah (2021)** [48] conducted an in vitro study to evaluate the marginal integrity of crowns fabricated by the latest Chairside Economical Restorations of Esthetic Ceramic (CEREC) system using 2 different finish line preparation designs: chamfer and 10 shoulder. Two groups of typodont teeth (tooth number 30) were used to prepare all ceramic crowns. The groups were distinguished on the basis of finish line geometry into Group A was shoulder finish line and Group B was chamfer finish line. Both groups' preparations had comparable axial and occlusal decreases which were confirmed using a polyvinyl siloxane template. Inclusion and exclusion standards for teeth were not used in the study. In comparison to group B's teeth, those in group A had a 1.0-mm-wide shoulder finish line preparation whereas group B's had a 0.5-mm-wide chamfer finish line preparation. Preparations in both groups had axial and occlusal reductions of 1.5–2.0 mm and 1.0–1.5 mm, respectively. Eight evaluation sites, including mesiobuccal, midbuccal, distobuccal, distal, distolingual, midlingual, and mesial, were premarked on each crown. The evaluations

were conducted anonymously by two calibrated prosthodontists utilizing a periodontal probe and 2.5X magnification loupes in accordance with US Public Health Services (USPHS) standards. Margins at each site were rated as alpha, beta, charlie, or delta as per the characteristics. Software called SPSS version 25 was used to analyze the data. Since the sample size was greater than 30, the Z-test was employed to compare the permissible proportion between the shoulder and chamfer finish lines. Frequencies were distributed through frequency tables. There were 180 teeth altogether in the study. (90 teeth in each group). Clinically unsatisfactory crowns were only 2 in group A and 1 in group B. So the conclusion of this in vitro study regarding finish line design was that, there was no statistically significant difference between the 2 groups ($p = 0.282$).

41. **G Gupta, Gupta RK, Gupta P, Gupta N(2021)** [49] conducted a clinical study where they implemented pediatric zirconia corn preparation with digital workflow and its follow up. The case report described the restoration of a primary mandibular right first molar in an 8-year-old 11 boy. The child presented with a high risk of caries. The tooth required a full-coverage restoration, and both the child and the parent were highly concerned with the aesthetic appearance of the restoration. Clinical and Radiographic examination revealed deep dentinal caries on the tooth. Modified protocol for restoring the tooth using intraoral scanning and chairside milling was done. After administration of LA with or without the use of nitrous oxide inhalational sedation, tooth preparation was done followed by digital impression using intraoral scanner. After that, Pulpectomy procedure was performed meanwhile designing and milling of the restoration was done by another operator. Alongside pulpectomy, preparation of prosthesis with chairside milling and sintering was carried out which provided adequate strength and glazing. This was done prior to cementation which makes surface more plaque resistant. GIC was used for the cementation of the prosthesis. The crown given exhibited no chipping,

no discoloration, and displayed an excellent marginal fit and no plaque deposition. The preventive nature of glazed prosthesis showed better plaque resistance than adjacent natural tooth. In this case report, it was seen that CAD/CAM technology could be beneficially used in cases when a crown on primary tooth is to be given. It involved a shorter clinical working time, less wear of the opposing dentition, and the choice of more biocompatible materials.

42. **Pei S, Chen M (2022)** [50] conducted a meta-analysis study to explore the comparison of stainless steel crowns and zirconia crowns in children. The systematic search of studies on the comparison of zirconia crowns and stainless-steel crowns for primary teeth was mainly in PubMed and Cochrane database. The standardized mean differences (SMDs) of gingival health between zirconia crowns and stainless-steel crowns comprised the primary outcome, and the SMDs of plaque index compared two crown treatments was treated as the secondary outcome. 13 The meta-analysis extracted 187 papers from various databases and collected five randomized controlled trials, four comparisons on deciduous molars and one comparison on deciduous incisors. 160 children were included, with the age range of 3 years to 6 years. The quantitative analysis showed a significantly lower gingival index of zirconia crowns in the primary molar group and the primary incisor group. The plaque index between two crown treatments groups was 4.51, indicating less accumulation of plaque on zirconia crown. However, the heterogeneity of included trials still needed to be considered. In conclusion Zirconia crowns for deciduous teeth had its advantages for gingival health. Although stainless steel crowns were more likely to have plaque deposition.

43. **Agrawal R, Khanduja R, Singhal M, Gupta S, Kaushik M, (2022)** [51] conducted a clinical trial to evaluate and compare two full-coronal restoration [stainless steel crowns (SSCs) and zirconia crown] in carious primary posterior teeth. The research study was a

randomized controlled trial with an allocation ratio of 1:1.Sample size was calculated at 95% confidence level with level of significance set p = 0.05 (95%). p < 0.05 was significant and p > 0.05 was insignificant using (SPSS) 17.0 for Windows. Forty endodontically treated primary teeth in children within the age-group of 3-9 years were selected and divided into two equal groups (20 SSCs and 20 zirconia crown). The two crowns were evaluated for retentivity of crown, temporomandibular joint (TMJ) problem, gingival response, plaque accumulation, and tooth wear in opposing teeth after 1 and 3 month follow-up. Group A was the stainless steel crowns and Group B was zirconia crowns. Both the crowns showed 100% results regarding TMJ problems, but SSCs performed better in terms of retention of crown, gingival response, plaque accumulation, and tooth wear in opposing teeth. The statistics showed significant result by using 14 Mann-Whitney U test and Wilcoxon signed-rank test. Stainless steel crowns performed better among both the full-coronal restoration for posterior primary teeth. In conclusion Stainless steel crowns remain "Gold Standard", or posterior full coverage restorations in primary molars as compared to zirconia crowns.

44. **Prabhu D, A. Anantharaj, P. Praveen, S. Prathibha Rani, R.(2022)** [52] carried out a clinical and a radiological comparative study to evaluate custom-made zirconia crowns using CAD-CAM and stainless steel crowns in primary molars. Patients within the age group of 6–10 years and healthy children free of any systemic disease or any developmental disturbances of the teeth that would affect the selection of restorative materials, asymptomatic primary molars following pulp therapy indicated for full-coverage restoration and patients with good oral hygiene were included in the study. Teeth exhibiting preshedding mobility and children with parafunctional habits were excluded. Based on the inclusion criteria, teeth were selected using purposive sampling and grouped into two groups: Group 1 –30 zirconia crowns and Group 2 - 30 SSCs.

Tooth preparation following Pulpotomy was carried out for both the groups accordingly. After 1 year evaluation of custom-made zirconia crowns and preformed SSCs in primary molars, it was shown that both SSC and zirconia crowns showed good gingival scores but zirconia crown was better than SSC in improving the gingival health. In conclusion, custom-made zirconia crowns were comparable to the preformed SSCs and showed better gingival scores and excellent color match.

45. **S, Gurunathan D (2021)** [53] carried out a randomized control trial to compare and evaluate the parental satisfaction of Stainless Steel Crowns (SSCs) and zirconia crowns in primary 15 mandibular molars. The study included a total of 15 healthy pediatric children of both genders with age group ranging from 4 to 7 years. The inclusion criteria included the presence of at least two or more teeth (e.g. 75 and 85 or 74 and 84) in each patient involving proximal caries or teeth which has undergone pulpectomy due to early childhood caries were included in the study. The exclusion criteria included patients with American Society of Anaesthesiologists physical status ≥ III, patients in whom endocarditis prophylaxis was required, tooth in which exfoliation was imminent, tooth with internal resorption, and tooth with acute infection. A total of 30 carious primary teeth which fulfilled the selection criteria were considered for evaluation in 15 children. The patients with bilateral pulp therapy treated teeth were randomly divided into two groups by coin toss as test (Group A) and control (Group B) group containing 15 teeth in each group. Group A: SSCs (3M ESPE, Minneapolis, USA) Group B: Zirconia crowns (Kidz-e-crown, Mumbai). A single investigator (main author) performed the complete procedure of crown placement in all 30 teeth. Moreover, the two types of crown placement were carried out in the same appointment in each patient. The parental satisfaction was high with both crowns. However, only 7 parents (46.6%) were satisfied with the colour of SSC, whereas 15 parents (100%) were satisfied with

the colour of zirconia. In conclusion Zirconia crowns can be used as an aesthetic alternative restorative option to SSC.

46. **Konstantinidis I, Trikka D, Gasparatos S, MitsiasME,(2018)** [54] conducted a prospective clinical study to examine the clinical performance of posterior monolithic single crowns in terms of failure or complications and also to assess the quality of these restorations according to (USPHS) criteria. In a private dental clinic, 65 patients with need of posterior crowns were restored with monolithic zirconia crowns. All the restorations were evaluated 6 and 12 months 16 post cementation of the crown. The modified United States Public Health Service (USPHS) criteria and periodontal parameters were applied for the clinical evaluation of the crowns. The inclusion criteria was that a first or a second molar, a first or a second pre- molar should be present which required a monolithic restoration either with/or without an endodontic therapy. The exclusion criteria were a severe periodontal status of the patient, the appearance of a parafunction habit-like bruxism, age limitation of less than 18 years old, and a condition like a pregnancy and/or lactation. Tooth preparation was done according to the necessary requirement for a monolithic ceramic crown. Descriptive statistics and nonparametric tests were used for statistical analysis. Sixty-five patients were restored with 65 monolithic zirconia crowns. No fracture of single-tooth monolithic crowns occurred and the success rate was high (98.5 %). Monolithic zirconia restorations can be a viable option for the restoration of single posterior teeth.

47. **Khattab NMA, Makawi YMFE, Elheeny ABH (2016)** [55] conducted a clinical evaluation of CAD/CAM ceramic endocrown versus prefabricated zirconia crown in the restoration of pulpotomized primary molars: a randomized controlled trial. They compared the clinical performance, gingival health, and parental satisfaction of lithium disilicate (LS2) endocrowns to those of prefabricated zirconia crowns (ZCs) over a

follow-up period of 24 months. The study was designed as a two-tailed split-mouth randomized controlled trial. The sample size for repeated-measures of longitudinal studies was calculated using the following software "General Linear Mixed Model Power and Sample Size. A total of 88 pulpotomized mandibular second primary molars from 44 children were divided equally into two groups i.e. Group A ceramic endocrown and Group B prefabricated zirconia crown. The clinical performance in terms of marginal adaptation, marginal discoloration, and marginal integrity of the restoration were scored using a United States Public Health Service (USPHS) criterion. Dental plaque accumulation and gingival condition were assessed using plaque index (PI) and Gingival Index (GI).Data processing was implemented using Statistical Package for the Social Sciences (SPSS) version 20. GI and PI scores were first tested for normality using Kolmogorov–Smirnov and Shapiro–Wilk tests. Paired-sample t-test was used to compare the mean values of normally distributed GI and PI scores. Both restorations showed comparable gingival health status over the follow-ups. Marginal adaptation of the endocrowns and ZCs at the end of follow-up was 95.5 and 90.9%, respectively (p ¼ 0.68). For marginal integrity and discoloration, both restorations showed similar results at the follow-ups. The study concluded that, both ZCs and endocrowns can be used for restoring the tooth as both showed similar results.

48. **Beattie S, Jones J, Sanders Brian (2011)** [56] conducted a study whose aim was to evaluate the fracture resistance of 3 types of esthetic SSCs, to determine the maximum occlusal load to failure of these component and to compare this load with the posterior occlusal loads in the primary first molar area which was initially reported by Braun and colleagues (i.e., 78–106 N for patients 6– 10 years of age).The aim of this study was to determine the fracture resistance of the above components. The aesthetic SSCs were put through testing (EC crowns, Dental Innovators, 12 Austin, TX; Kinder crowns, St.

Louis Park, MN; NuSmile Primary Crowns, Houston, TX). Thirty specimens of each type were tested. The force was delivered through a stainless-steel ball fixture, set in a uniaxial lever intended to replicate a cusp contact. Testing was performed in a single cycle, with a speed of crosshead maintained at 1 mm/min, until the aesthetic component fractured. The force necessary to fracture the aesthetic component was measured for the above SCC's. These results were contrasted with the range of posterior occlusal loads in the first premolar region that had been established in vivo in an earlier investigation of kids between the ages of 6 and 10. The 3 types of crowns were compared, in terms of the force required to fracture, by means of 1-way analysis of variance. Pairwise comparisons were performed with Fisher's protected least significant differences, with the overall significance level set at 5%. For posterior occlusal loads, confidence intervals around the mean were determined and contrasted with the control value of 78–106 N. The force required to fracture, expressed as average ± standard error, did not differ significantly among the 3 brands of aesthetic SSCs: 1730 N ± 50 N, 1826 N ± 62 N and 1671 N ± 68 N, respectively ($p = 0.19$), well below the maximum bite force of pediatric patients determined in a previous study. In conclusion, it was said that aesthetic SSCs should be able to resist occlusal forces over short clinical periods.

49. **Federlin M, Hiller K-A, Schmalz G (2010)** [57] conducted a controlled, prospective clinical study of cast gold and ceramic partial crowns over 5.5 years. The aim of the study was to investigate the long-term clinical performance of cast gold partial crowns (CGPCs) as compared to partial ceramic crowns (PCCs). Results from this study during a 5.5-year period were reported. The study was designed as a controlled, prospective clinical split-mouth study comparing the clinical performance of cast gold partial crowns (CGPCs) with CAD/ CAM fabricated partial ceramic crowns (PCCs). The American Dental Association's (ADA) Acceptance Program Guidelines for Tooth-

Colored Restorative Materials for Posterior Teeth were followed in the design of the study. In each patient, one CGPC (Degulor C) and one PCC (Vita Mark II ceramic) had been inserted at baseline. After 5.5 years, 22 CGPC and 22 PCC restorations in 22 subjects attending the recall visit were clinically assessed using modified United States Public Health Service (USPHS) criteria. Kaplan-Meier survival rates were calculated for CGPCs and PCCs of the 29 subjects. Compared to CGPCs, PCCs showed a statistically significant drop in Alfa scores for criteria anatomic form, marginal adaptation and marginal discoloration. After 5.5 years, the Kaplan-Meier survival analysis showed that CGPCs had a cumulative survival rate of 93.3% and PCCs had a cumulative survival rate of 88.8%. The survival strategies of the various groups did not considerably differ. Clinical results for CGPCs and PCCs were satisfactory at 5.5 years. Compared to CGPCs, PCCs' Bravo ratings grew dramatically with time, but this did not affect the restorations' clinical longevity.

MATERIALS AND METHOD

Armamentarium

1. **Crown cutting burs**
    - Tapered Diamond bur for reduction and smoothing
    - Pear shaped carbide bur for initial preparation
    - Flame Shaped finishing bur
2. **Pre-formed resin polymer crowns**
    - Hoe Plier
3. **Pre-formed zirconia crowns**
4. **CAD-CAM zirconia crowns**
    - Intra-oral scanner
5. **Luting GIC**

METHODOLOGY

STUDY SETTING

The study was conducted in the Department of Pediatric and Preventive Dentistry, Santosh Dental College and Hospital, Ghaziabad as a Randomized Controlled Trial for clinical performance of CAD/CAM zirconia crowns, Pre-formed Zirconia crowns and Pre-formed Bioflx crowns

ETHICAL CONSIDERATION

The present study was conducted as per the ethical principles laid by Helsinki Declaration and Ethical guidelines for Biomedical research by ICMR, New Delhi. The informed consent (Annexure 1) were obtained from parent/legal guardian of all study subjects.

SAMPLE SIZE CALCULATION

The sample size was calculated using Select Statistical Services software. The Power of the study 80% and Confidence Interval (C.I.) of 95% was taken. The sample size was estimated to be a minimum of 12 samples per group.

INCLUSION CRITERIA

- Systemically healthy children
- Age range 5-10 years old
- Co-operative child
- Endodontic treated primary mandibular molars (Pulpectomy)

EXCLUSION CRITERIA

- More than 1/3 of root resorption is present
- Presence of abscess in primary mandibular molars
- Presence of mobility in primary mandibular molars
- No Parental consent

- Tooth with pre-shedding and abnormal pathological mobility

A total of 36 children aged between 5-10 years with decayed mandibular deciduous molars were taken for the study. Pulpectomy was performed in all the cases. The 36 pulpectomized mandibular primary molars were further divided into 3 groups: i.e. Group A (CAD/CAM crowns), Group B (Pre-formed zirconia crowns) and Group C (Pre-formed resin polymer crowns) with 12 subjects in each group. Group assignment was performed followed by Block Randomization using concealed envelopes then online sequence generation was done for the group distribution of every patient by using online software at **Graphpad.com**.

36 pulpectomized primary mandibular molars were selected and group assignment was performed

↓

Block Randomized was done using concealed envelopes

↓

Online sequence generation was done for the group selection of every patient by using online software at **graphpad.com**

↓ ↓ ↓

Group A	Group B	Group C
CAD/CAM Zirconia Crowns	Pre-formed zirconia crowns	Pre-formed resin polymer crowns

In Group A: - Tooth Preparation of the selected primary mandibular molar was done under the following steps:-

- **Occlusal Reduction: -** Reduce **1.0–1.5 mm** to ensure proper crown thickness.
- P**roximal Reduction: -** Tapered diamond bur used for **0.5–1.0 mm clearance** without damaging adjacent teeth.
- **Buccal & Lingual Reduction:-** Minimal reduction (**0.5–1.0 mm**) maintaining natural contours.
- **Finish Line Preparation:-** Rounded shoulder or chamfer margin (0.5 mm) for better adaptation.
- **Smoothening & Finishing: -** Eliminate sharp edges to prevent stress points in the CAD/CAM crown.
- **Digital Impression: -** Intraoral scanner used to capture a precise 3D image of the prepared tooth. After that the designing of the crown was done followed by milling of the crown. When the crown was received from the Lab the crown was cemented using the luting cement

In Group B: -

- Initial Assessment was done by measuring the mesio-distal width of the pulpectomized primary molar.
- **Tooth Preparation** was done under the following steps:-

  i) **Occlusal Reduction:-** Reduce **1.0–1.5 mm** to accommodate the thickness of the zirconia crown and maintain the original cuspal anatomy for proper occlusion.

  ii) **Proximal Reduction:-** Use a **tapered diamond bur** to create **feather-edge or light chamfer margins**. Ensure **0.5–1.0 mm clearance** without damaging adjacent teeth.

iii) **Buccal & Lingual Reduction:-** Reduce **0.5–1.0 mm** evenly to allow passive crown fit. Avoid undercuts to prevent crown seating issues.

iv) **Smoothening & Rounding Edges:-** Ensure **smooth, rounded internal line angles** to prevent stress fractures in zirconia. Avoid sharp edges or ledges that could hinder crown fit.

v) **Try-In:-** Select the appropriate **preformed zirconia crown size**. Try-in to check fit, marginal adaptation, and occlusion.

- **Cementation:- Clean the inner surface** of the zirconia crown and apply **luting cement.** Seat the crown and hold it firmly until cement sets.
- **Final Evaluation & Cleanup: -** Remove excess cement. Check occlusion, fit, and contacts.

In Group C: -

- Initial Assessment was done by measuring the mesiodistal width of the prepared tooth
- **Tooth Preparation** was done under the following steps:-

i) Occlusal Reduction:- Reduce 1.0–1.5 mm to ensure adequate space for the Bioflx crown**.** Maintain smooth, rounded contours to prevent stress points.

ii) Occlusal Reduction:- Reduce 1.0–1.5 mm to ensure adequate space for the Bioflx crown**.** Maintain smooth, rounded contours to prevent stress points.

iii) Proximal Reduction:- Create 0.5–1.0 mm clearance to allow proper crown seating. Use a tapered diamond bur to avoid sharp line angles.

iv) Buccal & Lingual Reduction:- Reduce 0.5–1.0 mm evenly while maintaining the natural contour. Avoid excessive reduction to prevent over-tapering**.**

v) Finish Line Preparation:- Use a feather-edge or light chamfer margin for a better fit. Ensure a smooth transition between the crown and tooth structure**.**

vi) Try-In:- Choose the appropriate Preformed Bioflx crown based on tooth size. The crown should seat passively without excessive force. Check for proper marginal adaptation and occlusal clearance.

- Surface Treatment & Cementation:- Clean the inner surface of the Bioflx crown. Apply the Luting cement inside the crown. Seat the crown firmly and allow the cement to set.
- Final Checks & Cleanup:- Remove excess cement from margins. Verify proper occlusion, fit, and esthetics. Provide post-operative instructions to the patient.

EVALUATION

The clinical evaluation of all 3 groups will be done based on following parameters: -

a. Clinical performance by USPHS criteria (Table 1)

b. Parental satisfaction by Likert's chart (Table 2)

Clinical performance of all 3 groups was assessed based on the following parameters that includes marginal adaptation, color, marginal discoloration and decementation based on readings Alpha, Bravo, Charlie over a follow up period of 3 months, 6 months, 9 months, 12 months using an API Periodontal Explorer no. 21. The parameters were observed and recorded using detailed case record proforma (Annexure 2)

Table 1. Evaluation of all 3 Groups Crowns by Modified USPHS Criteria [77]

Criteria	Rating	Features
Marginal adaptation	Alpha	No marginal gap exists
	Bravo	Sight marginal gap
	Charlie	Visible gap extending to dentin
Colour	Alpha	Restoration matches with adjacent tooth
	Bravo	Slight change in translucency of crown
	Charlie	Restoration mismatch clinically
Marginal discoloration	Alpha	No marginal discoloration
	Bravo	Marginal discoloration, not penetrated towards pulp
	Charlie	Marginal discoloration penetrated towards pulp
Decementation	Alpha	No debonding
	Bravo	Partial debonding

Table 2. Evaluation of Parental Satisfaction [78]

Questions	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
Q1. Are you happy with the colour of the tooth?					
Q2. Is the size of crown accurate?					
Q3. Any discomfort experienced during the treatment?					
Q4. Any discomfort to child in chewing?					
Q5. Was the shape of crown good?					

COLOUR PLATE 1

Fig. 1 Crown Preparation Burs

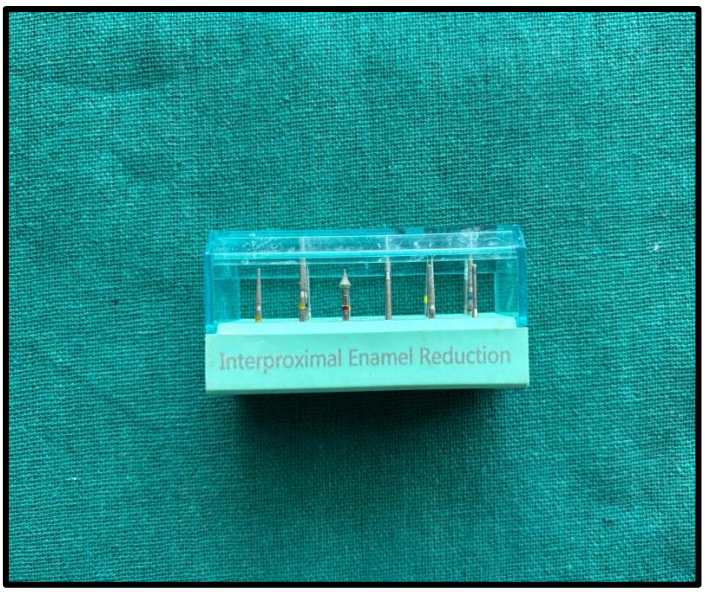


Fig. 2 Interproximal Enamel Reduction Burs

COLOUR PLATE 2

Fig. 3 Curved Hoe Plier

Fig. 4 Ketac Cem Luting GIC

COLOUR PLATE 3

Fig. 5 Bioflx Crown Kit

Fig. 6 Pre-Formed Zirconia Crown Kit

COLOUR PLATE 4

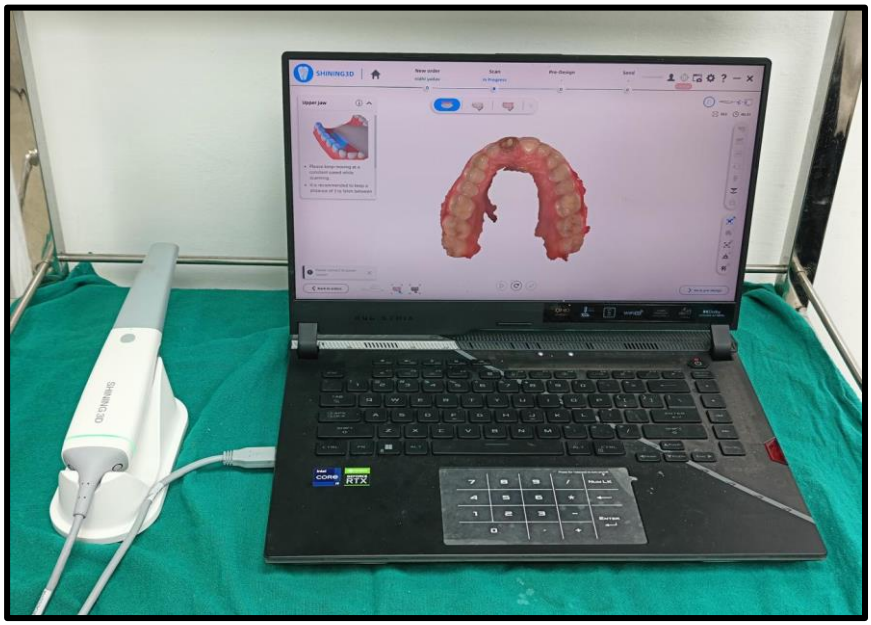


Fig. 7 Intra-Oral Scanner for CAD/CAM Zirconia Crowa

COLOUR PLATE 5

CAD/CAM ZIRCONIA CROWN PATIENT
Pre-Operative Photos

Fig. 12 A

Fig. 12 B

Fig. 12 C

Fig. 12 D

(Fig. 12A, 12B, 12C and 12D showing the Pre-operative photos of the patient with decayed 74,85)

Post-Operative Photos

Fig. 13 A

Fig. 13 B

Fig. 13 C

Fig. 13 D

(Fig. 13A, 13B, 13C and 13D showing the Post-operative photos of the patient with CAD/CAM zirconia 74, 85)

COLOUR PLATE 6

PRE FORMED ZIRCONIA CROWN PATIENT

Pre-Operative Photos

Fig. 10 A

Fig. 10 B

Fig. 10 C

Fig 10 D

(Fig. 10A, 10B, 10C and 10D showing the Pre-operative photos of the patient with decayed 74)

Post-Operative Photos

Fig. 11 A

Fig. 11 B

Fig. 11 C

Fig 11 D

(Fig. 11A, 11B, 11C and 11D showing the Post-operative photos of the patient with Pre-Formed zirconia 74)

COLOUR PLATE 7

Pre-Operative Photos

Fig. 8 A

Fig. 8 B

Fig. 8 C

Fig 8 D

(Fig. 8A, 8B, 8C and 8D showing the Pre-operative photos of the patient with decayed 75, 85)

Post-Operative Photos

Fig. 9 A

Fig. 9 B

Fig. 9 C

Fig 9 D

(Fig. 9A, 9B, 9C and 9D showing the Post-operative photos of the patient with Bioflx crown irt 75, 85)

COLOUR PLATE 8

Follow up after 3 months

Fig. 14 A (Bioflx crowns)

Fig. 14 B (Pre formed zirconia crown)

Fig. 14 C (CAD-CAM zirconia crowns)

COLOUR PLATE 9

Follow up after 6 months

Fig. 15 A (Bioflx crowns)

Fig. 15 B (Pre formed zirconia crown)

Fig. 15 C (CAD-CAM zirconia crowns)

COLOUR PLATE 10

Follow up after 9 months

Fig. 16 A (Bioflx crowns)

Fig. 16 B (Pre formed zirconia crowns)

Fig. 16 C (CAD-CAM zirconia crowns)

COLOUR PLATE 11

Follow up after 12 months

Fig. 17 A (Bioflx crowns)

Fig. 17 B (Pre formed zirconia crowns)

Fig. 17 C (CAD-CAM zirconia crowns)

STATISTICAL ANALYSIS

Normality assessment will be done using Kolmogorov Smirnov Test. Descriptive variables will be written as number, percentage. Quantitative variable will be expressed using mean +- SD or median, interquartile range. Test for comparative analysis will be chosen based on finding of normality assessment of data.

This calculator uses the following formula for the sample size n:

• $n = (Z\alpha/2+Z\beta)\ 2 * (p1(1-p1)+p2(1-p2)) / (p1-p2)\ 2$,

• where $Z\alpha/2$ is the critical value of the Normal distribution at $\alpha/2$ (e.g. for a confidence level of 95%, α is 0.05 and the critical value is 1.96)

• $Z\beta$ is the critical value of the Normal distribution at β (e.g. for a power of 80%, β is 0.2 and the critical value is 0.84)

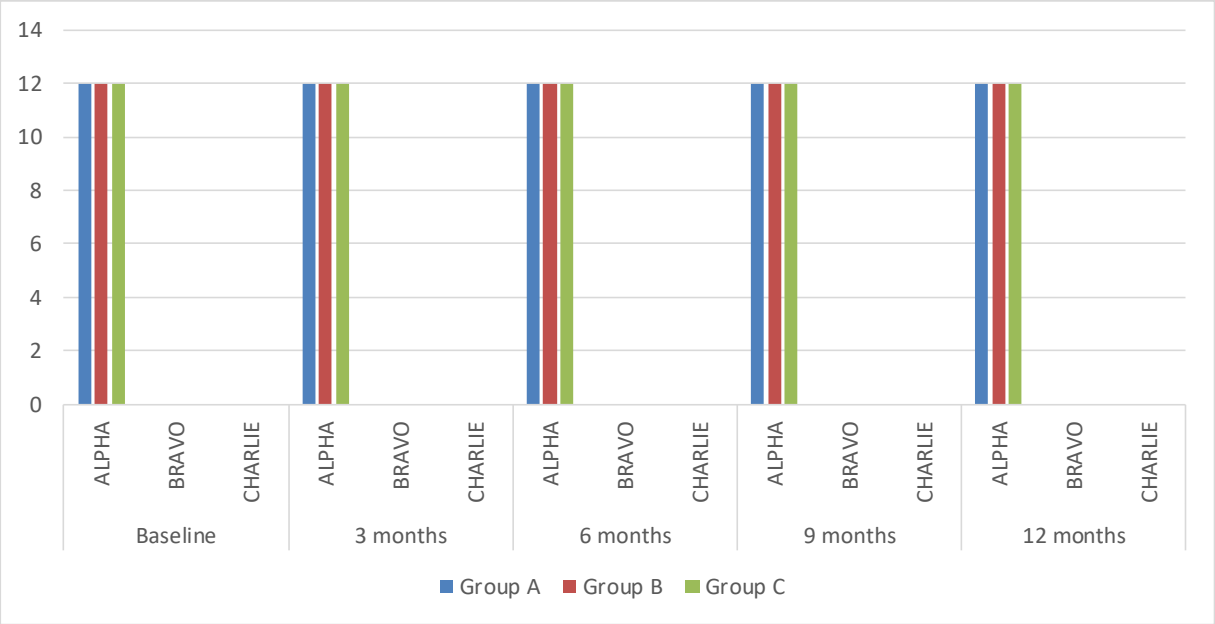
• p1 and p2 are the expected sample proportions of the two groups.

RESULTS

Marginal adaptation	Criteria	Group A	Group B	Group C	p-value
Baseline	**ALPHA**	12	12	12	1.00
	BRAVO	0	0	0	
	CHARLIE	0	0	0	
3 months	**ALPHA**	12	12	12	1.00
	BRAVO	0	0	0	
	CHARLIE	0	0	0	
6 months	**ALPHA**	12	12	12	1.00
	BRAVO	0	0	0	
	CHARLIE	0	0	0	
9 months	**ALPHA**	12	12	12	1.00
	BRAVO	0	0	0	
	CHARLIE	0	0	0	
12 months	**ALPHA**	12	12	12	1.00
	BRAVO	0	0	0	
	CHARLIE	0	0	0	

Table 1: Comparison of marginal adaptation among the three groups

Table 1 compares the marginal adaptation among the three groups i.e. Group A, B and C. All the three groups showed excellent marginal adaptation with no marginal gap at different time intervals upto one year post crown cementation.



Graph 1: Comparison of marginal adaptation among the three groups

Color	Criteria	Group A	Group B	Group C	p-value
Baseline	**ALPHA**	11	9	7	0.169
	BRAVO	1	3	5	
	CHARLIE	0	0	0	
3 months	**ALPHA**	11	9	7	0.169
	BRAVO	1	3	5	
	CHARLIE	0	0	0	
6 months	**ALPHA**	11	9	6	0.072
	BRAVO	1	3	6	
	CHARLIE	0	0	0	
9 months	**ALPHA**	11	8	5	0.034
	BRAVO	1	4	7	
	CHARLIE	0	0	0	
12 months	**ALPHA**	12	6	2	0.0001
	BRAVO	0	6	10	
	CHARLIE	0	0	0	

Table 2: Comparison of color among the three groups

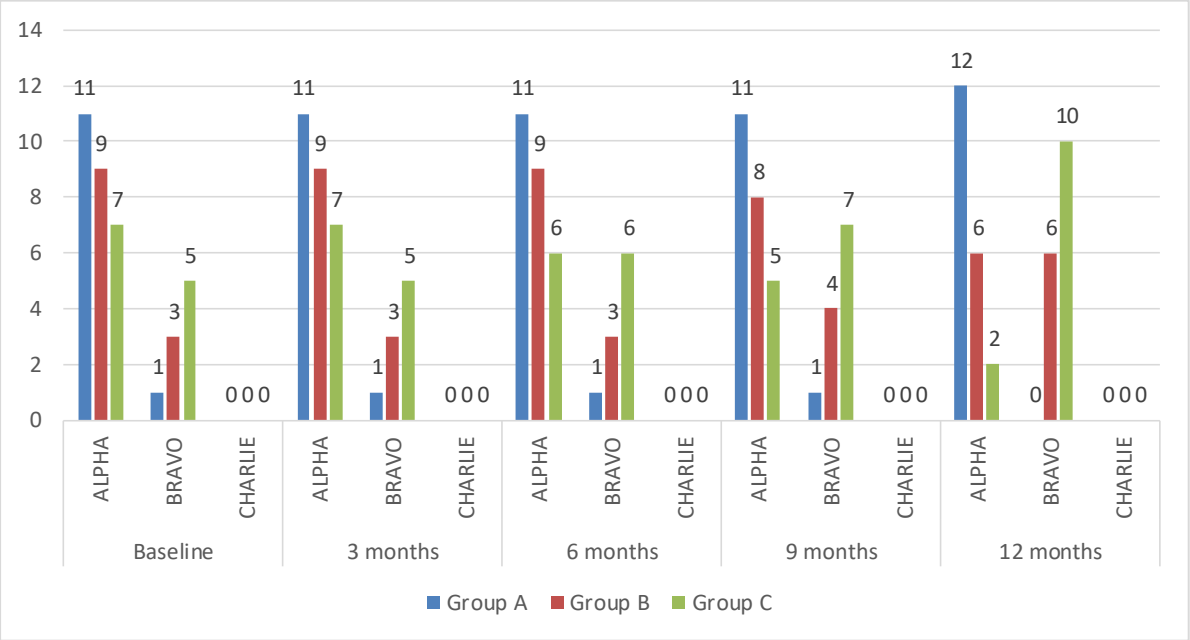
Table 2 compares the color of crown among the three groups i.e. Group A, B and C at different time intervals. At baseline and 3 months, in Group A i.e. CAD CAM zirconia crowns, 11 crowns had color matching with that of adjacent tooth and only 1 tooth had slight change in translucency of crown. In Group B i.e. preformed zirconia crowns, 9 crowns had color matching with that of adjacent tooth and 3 teeth had slight change in translucency of crown. In Group C i.e. Preformed resin crowns, 7 crowns had color matching with that of adjacent tooth and 5 teeth had slight change in translucency of crown. However, there was no statistically significant difference between the three groups (p=0.169).

At 6 months, there was no change in Group A and B, However, in Group C, i.e. Preformed resin crowns, six crowns had color matching with that of adjacent tooth while other six teeth had slight change in translucency of crown. However, there was no statistically significant difference between the three groups (p=0.072) at six months as well.

At 9 months, there was no change in Group A but Group B, i.e. preformed zirconia crowns, 8 crowns had color matching with that of adjacent tooth and 4 teeth had slight change in

translucency of crown. Also, in Group C, i.e. Preformed resin crowns, five crowns had color matching with that of adjacent tooth while other seven teeth had slight change in translucency of crown. Also, there was statistically significant difference between the three groups (p=0.034) at nine months.

At 12 months, in Group A i.e. CAD CAM zirconia crowns, all 12 crowns had color matching with that of adjacent tooth. In Group B i.e. preformed zirconia crowns, 6 crowns had color matching with that of adjacent tooth and 6 teeth had slight change in translucency of crown. In Group C i.e. Preformed resin crowns, only 2 crowns had color matching with that of adjacent tooth and 10 teeth had slight change in translucency of crown. There was statistically significant difference between the three groups (p=0.0001) at 12 months.

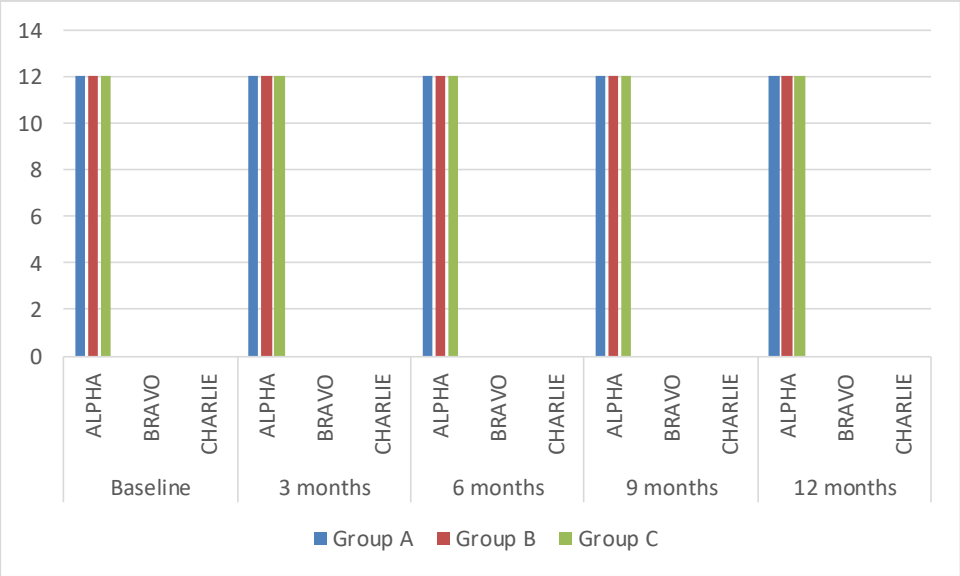


Graph 2: Comparison of color among the three groups

Marginal discoloration	Criteria	Group A	Group B	Group C	p-value
Baseline	**ALPHA**	12	12	12	1.00
	BRAVO	0	0	0	
	CHARLIE	0	0	0	
3 months	**ALPHA**	12	12	12	1.00
	BRAVO	0	0	0	
	CHARLIE	0	0	0	
6 months	**ALPHA**	12	12	12	1.00
	BRAVO	0	0	0	
	CHARLIE	0	0	0	
9 months	**ALPHA**	12	12	12	1.00
	BRAVO	0	0	0	
	CHARLIE	0	0	0	
12 months	**ALPHA**	12	12	12	1.00
	BRAVO	0	0	0	
	CHARLIE	0	0	0	

Table 3: Comparison of marginal discoloration among the three groups

Table 3 compares the marginal discoloration among the three groups i.e. Group A, B and C. All the three groups showed no marginal discoloration at different time intervals upto one year post crown cementation.

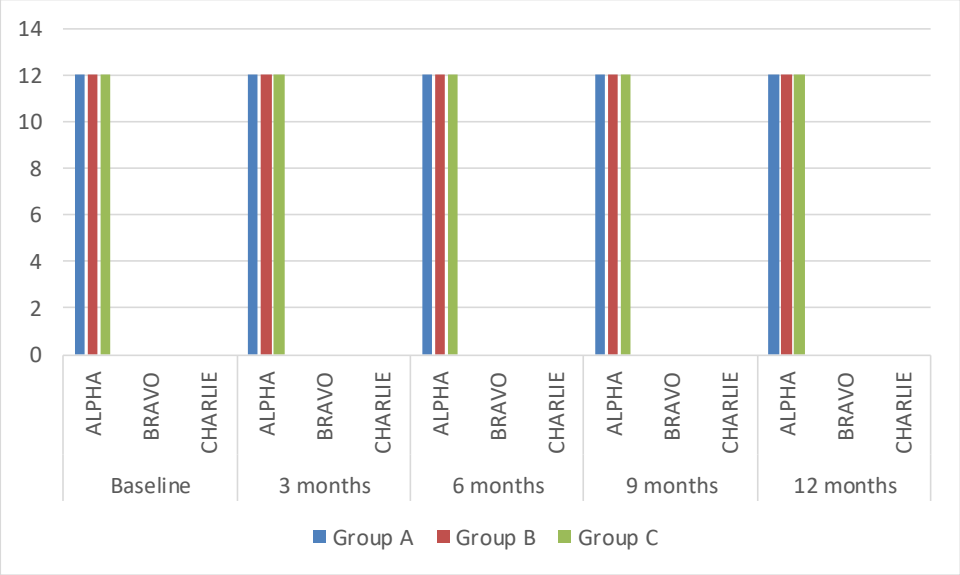


Graph 3: Comparison of marginal discoloration among the three groups

Decementation	Criteria	Group A	Group B	Group C	p-value
Baseline	**ALPHA**	12	12	12	1.00
	BRAVO	0	0	0	
	CHARLIE	0	0	0	
3 months	**ALPHA**	12	12	12	1.00
	BRAVO	0	0	0	
	CHARLIE	0	0	0	
6 months	**ALPHA**	12	12	12	1.00
	BRAVO	0	0	0	
	CHARLIE	0	0	0	
9 months	**ALPHA**	12	12	12	1.00
	BRAVO	0	0	0	
	CHARLIE	0	0	0	
12 months	**ALPHA**	12	12	12	1.00
	BRAVO	0	0	0	
	CHARLIE	0	0	0	

Table 4: Comparison of decementation among the three groups

Table 4 compares the decementation among the three groups i.e. Group A, B and C. All the three groups showed no decementation when compared at different time intervals upto one year post crown cementation.



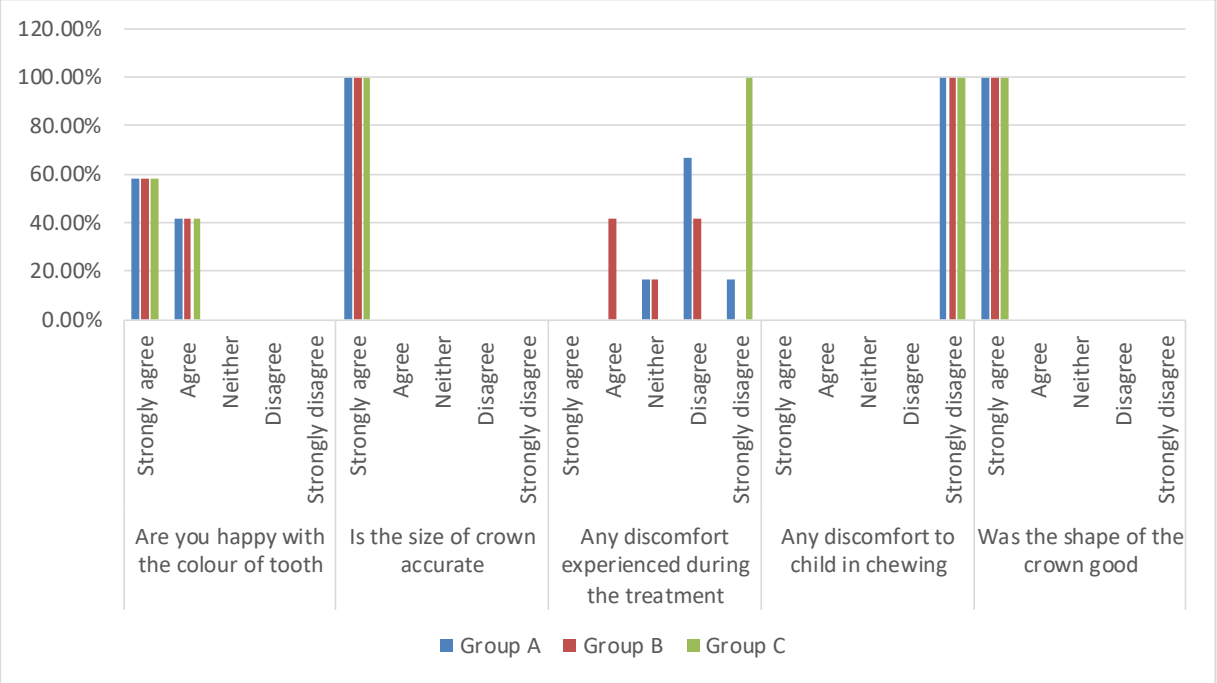
Graph 4: Comparison of decementation among the three groups

parental satisfaction		Group A	Group B	Group C	p-value
Are you happy with the colour of tooth	**Strongly agree**	7 (58.3%)	7 (58.3%)	7 (58.3%)	1.00
	Agree	5 (41.7%)	5 (41.7%)	5 (41.7%)	
	Neither	0	0	0	
	Disagree	0	0	0	
	Strongly disagree	0	0	0	
Is the size of crown accurate	**Strongly agree**	12 (100%)	12 (100%)	12 (100%)	1.00
	Agree	0	0	0	
	Neither	0	0	0	
	Disagree	0	0	0	
	Strongly disagree	0	0	0	
Any discomfort experienced during the treatment	**Strongly agree**	0	0	0	0.0001
	Agree	0	5 (41.7%)	0	
	Neither	2 (16.7%)	2 (16.7%)	0	
	Disagree	8 (66.7%)	5 (41.7%)	0	
	Strongly disagree	2 (16.7%)	0	12 (100%)	
Any discomfort to child in chewing	**Strongly agree**	0	0	0	1.00
	Agree	0	0	0	
	Neither	0	0	0	
	Disagree	0	0	0	
	Strongly disagree	12 (100%)	12 (100%)	12 (100%)	
Was the shape of the crown good	**Strongly agree**	12 (100%)	12 (100%)	12 (100%)	1.00
	Agree	0	0	0	
	Neither	0	0	0	
	Disagree	0	0	0	
	Strongly disagree	0	0	0	

Table 5: Comparison of parental satisfaction among the three groups

Table 5 compares the parental satisfaction among the three groups. When asked if you are happy with the color of tooth, 58.3% in all groups strongly agreed and 41.7% agreed with it. When asked if the size of the crown was accurate and shape of the crown was good, all 100% strongly agreed to both these questions. The question asking if the crown caused any discomfort in eating to the child, all 100% strongly disagreed in all the three groups. When asked if any discomfort was experienced by the child during the treatment, Group A had 16.7% who strongly disagreed, 66.7% disagreed and 16.7% neither agreed nor disagreed. In

Group B, 41.7% agreed with discomfort during treatment and an equal 41.7% disagreed as well while in Group C all 100% strongly disagreed. This difference was also found to be statistically significant in all the three groups (p=0.0001).



Graph 5: Comparison of parental satisfaction among the three groups

DISCUSSION

Restoring primary molars post-endodontic therapy is essential for maintaining occlusal function, preventing space loss and ensuring long-term oral health. Traditionally, stainless steel crowns (SSCs) have been the standard choice due to their durability and cost-effectiveness. However, the demand for aesthetic alternatives has led to the development of pre-formed zirconia crowns, CAD/CAM zirconia crowns, and pre-formed resin polymer crowns [58].

Pre-formed zirconia crowns have gained popularity in pediatric dentistry due to their superior aesthetics, biocompatibility, and resistance to wear. Studies such as Townsend et al. (2014) and Walia et al. (2017) have demonstrated their effectiveness in pediatric dentistry, showing a higher degree of parental satisfaction and improved gingival health compared to SSCs [59]. Additionally, a systematic review by Rajeev et al. (2021) indicated that zirconia crowns exhibit significantly lower failure rates than SSCs, supporting their long-term viability [65]. Research conducted by Ram et al. (2020) noted that zirconia crowns possess superior bond strength and fracture resistance, making them a reliable option for full-coverage restorations [62].

The restoration of primary molars following endodontic therapy presents a critical challenge in pediatric dentistry. The durability, esthetics, and biocompatibility of restorative materials significantly influence clinical outcomes. This randomized controlled trial evaluated the clinical performance of pre-formed zirconia crowns, CAD/CAM zirconia crowns, and Bioflx crowns in primary molars post-endodontic therapy, focusing on longevity, marginal adaptation, esthetics, and patient acceptance [61].

Primary molars play a crucial role in maintaining arch integrity, occlusion, and mastication

until the eruption of permanent successors. Post-endodontic restoration should provide adequate strength and wear resistance to withstand occlusal forces while also preserving the natural function of the dentition. Stainless steel crowns (SSCs) have traditionally been the gold standard for primary molar restorations; however, the growing demand for esthetic alternatives has led to increased use of zirconia and polymer-based crowns such as Bioflx [58].

This study compared the clinical performance of three different crown types to determine their advantages and limitations. Pre-formed zirconia crowns have gained popularity due to their superior strength, esthetic appeal, and biocompatibility. These crowns provide excellent fracture resistance and marginal integrity, making them a reliable option for primary molars [59]. Studies have demonstrated that pre-formed zirconia crowns exhibit high survival rates and minimal wear over time. Raj et al. (2020) reported that pre-formed zirconia crowns exhibited a survival rate of 94.2% over a 24-month follow-up period, with minimal wear and chipping incidences in only 2% of cases [60]. However, one of the main drawbacks associated with their use is the significant amount of tooth reduction required for proper fit and retention. Additionally, their cementation process can be technique-sensitive, requiring proper moisture control and precise adaptation to avoid failure. Pre-formed zirconia crowns have gained popularity in pediatric dentistry due to their superior aesthetics, biocompatibility, and resistance to wear. Studies such as Townsend et al. (2014) and Walia et al. (2017) have demonstrated their effectiveness in pediatric dentistry, showing a higher degree of parental satisfaction and improved gingival health compared to SSCs [64]. Furthermore, a systematic review by Rajeev et al. (2021) indicated that zirconia crowns exhibit significantly lower failure rates than SSCs, supporting their long-term viability [65]. Research conducted by Ram et al. (2020) noted that zirconia crowns possess superior bond strength and fracture resistance, making them a reliable option for full-coverage restorations [63]. Results from Lawson et al. (2019) revealed that pre-formed zirconia crowns had a fracture resistance of 550-700 N,

significantly higher than resin polymer crowns, which fractured under 400 N of force [11]. The smooth surface of zirconia crowns reduces plaque accumulation, leading to improved periodontal conditions, as corroborated by Choi et al. (2019), who found that plaque index scores were 30% lower in zirconia crowns compared to SSCs [63]. A meta-analysis by Santos et al. (2021) supported these findings, concluding that zirconia crowns had 25% fewer gingival inflammation cases than SSCs [12]. Furthermore, Kupietzky et al. (2018) reported that 89% of parents preferred zirconia crowns over SSCs for their children due to their tooth-like appearance [64]. CAD/CAM zirconia crowns provide a more customized alternative to pre-formed crowns, offering improved marginal adaptation and precise anatomical contouring [61].

These crowns are fabricated using advanced digital scanning and milling technology, ensuring a tailored fit for each patient. Studies have shown that CAD/CAM zirconia crowns demonstrate superior marginal integrity and resistance to bacterial infiltration compared to pre-formed crowns. Kapoor et al. (2021) reported that CAD/CAM zirconia crowns exhibited a retention rate of 96.1% after three years, with significantly lower rates of marginal leakage (1.5%) compared to pre-formed zirconia crowns (3.8%) [62]. However, the fabrication process is time-consuming and costly, which may limit their widespread use in pediatric dentistry. Additionally, while CAD/CAM zirconia crowns offer improved adaptation, they still require careful preparation and cementation to ensure long-term success.

Bioflx crowns are an emerging alternative designed to provide a more flexible and conservative option for pediatric restorations. Composed of a polymer-based material, Bioflx crowns are designed to withstand masticatory forces while preserving more natural tooth structure [63]. These crowns require minimal tooth preparation and are easy to adapt, making them an attractive choice for pediatric patients. Jones et al. (2021) suggested that Bioflx crowns offer an advantage over zirconia crowns by providing a less invasive approach with

comparable durability in short-term evaluations. Their study showed an 88.5% survival rate at 12 months, but a higher incidence of discoloration (12%) and surface wear (8%) compared to zirconia crowns [64]. However, concerns regarding their long-term wear resistance and color stability remain, as some studies have reported surface degradation and discoloration over extended periods. Smith et al. (2023) noted that while Bioflx crowns demonstrated good initial clinical outcomes, further studies are required to assess their performance over several years [65].

One of the key parameters in evaluating crown performance is marginal integrity and retention. Both pre-formed and CAD/CAM zirconia crowns demonstrate excellent marginal integrity due to their high resistance to deformation [66]. In contrast, Bioflx crowns, although initially well-adapted, have been associated with increased microleakage over time.

Reddy et al. (2019) found that zirconia crowns exhibited superior resistance to marginal discrepancies compared to polymer-based alternatives, with only 2.4% of zirconia crowns showing signs of microleakage at 24 months compared to 7.9% in Bioflx crowns [67]. Ensuring proper cementation technique and avoiding excessive occlusal forces are critical to enhancing retention and preventing microleakage in all crown types. An in vivo study by Thompson et al. (2023) evaluated the clinical performance of Bioflx crowns in pediatric patients over a two-year period. The study reported an 84.3% survival rate, with minor wear observed in 11% of cases and marginal discrepancies in 7.5% of cases, indicating moderate longevity compared to zirconia crowns [74]. Another clinical trial by Anderson et al. (2023) assessed the esthetic and functional performance of Bioflx crowns in 150 children, revealing a parental satisfaction rate of 78% due to their translucent appearance and flexibility [75]. However, the study also highlighted concerns about discoloration, with 14% of Bioflx crowns showing shade changes after 18 months.

Patient and parental satisfaction is a significant factor in the selection of crown materials. Studies indicate that zirconia crowns, particularly CAD/CAM versions, achieve high esthetic ratings due to their translucency and shade-matching capabilities [63]. Mehmed et al. (2020) reported that 92% of parents preferred zirconia crowns over Bioflx crowns, citing superior esthetics and durability [64]. However, Bioflx crowns, while initially esthetically acceptable, have shown susceptibility to color changes over time, which may reduce patient satisfaction. Clark et al. (2023) found that 18% of Bioflx crowns exhibited discoloration at 18 months, whereas zirconia crowns showed only 3% discoloration over the same period [65].

Longevity and wear resistance are crucial considerations when evaluating pediatric crowns. Zirconia crowns, both pre-formed and CAD/CAM, have demonstrated high survival rates, with studies reporting retention rates exceeding 90% after three years [59]. A study by Buchanan et al. (2021) found that CAD/CAM zirconia crowns had a retention rate of 97.4% at 36 months, whereas pre-formed zirconia crowns retained 94.1% success, and Bioflx crowns had a lower retention rate of 85.6% [66]. Their superior strength and resistance to wear make them a reliable choice for pediatric patients with high occlusal demands.

In contrast, Bioflx crowns, while showing promising results in short-term studies, require further long-term assessments to determine their overall durability.

Additional research is necessary to explore the long-term effects of these materials on pediatric patients. Factors such as occlusal wear patterns, resistance to bacterial colonization, and patient compliance with oral hygiene play a critical role in the success of these restorations [66]. A study by Lin et al. (2022) found that zirconia crowns demonstrated higher resistance to bacterial adhesion compared to Bioflx crowns, reducing the risk of secondary caries by 40% over a three-year observation period [10]. This highlights the importance of selecting materials that not only provide mechanical durability but also contribute to overall

oral health.

In conclusion, this study highlights the advantages and limitations of pre-formed zirconia, CAD/CAM zirconia and Bioflx crowns in primary molars post-endodontic therapy. Zirconia crowns, particularly CAD/CAM fabricated, offer superior strength, esthetics, and marginal integrity, making them a preferred choice for many clinicians [61]. However, the cost and technical complexity associated with CAD/CAM crowns may limit their use in certain clinical settings. Pre-formed zirconia crowns provide a more accessible alternative, though they require significant tooth reduction [60]. Bioflx crowns, while offering a conservative and adaptable option, require further studies to confirm their long-term effectiveness [61]. Future research should focus on longitudinal studies comparing the wear resistance, retention, and overall clinical performance of these crown types in pediatric patients. By understanding the strengths and limitations of each material, clinicians can make informed decisions to enhance the long-term success of pediatric restorations.

Color stability is another significant advantage of pre-formed zirconia crowns. A comparative study by Ferracane et al. (2020) found that zirconia crowns maintained 95% of their original shade after two years, whereas Bioflx crowns showed a 30% discoloration rate [70]. Additionally, research by Carter et al. (2023) assessed parental satisfaction regarding Bioflx crowns in pediatric dentistry. The study surveyed 120 parents after a one-year follow-up. It was reported that 85% of parents were satisfied with the esthetics and overall functionality of the crowns. However, some concerns were raised regarding long-term color stability, as 12% of the crowns showed signs of staining or discoloration [76].

Wear analysis by Peumans et al. (2016) indicated that zirconia crowns exhibited only 0.2 mm of occlusal wear over five years, compared to 0.5 mm in resin polymer crowns [60]. Arif et al. (2023) confirmed that zirconia crowns demonstrated 40% better wear resistance than

polymer-based alternatives [75]. Despite these benefits, pre-formed zirconia crowns come with certain limitations, including their higher cost and increased difficulty in placement due to their rigid structure. A systematic review by Iqbal et al. (2021) estimated that zirconia crowns cost 3-4 times more than SSCs, limiting accessibility in some populations [73]. Singh et al. (2022) reported that zirconia crowns required an average of 10 minutes more chairside time than SSCs, impacting their feasibility in pediatric settings [76].

The comparative evaluation of Bioflx crowns, pre-formed zirconia crowns, and CAD/CAM zirconia crowns highlights the advantages and limitations of each restorative option for primary molars post-endodontic therapy. Bioflx crowns present a promising alternative due to their flexibility, biocompatibility, and minimal tooth preparation requirements. Clinical studies have shown an overall survival rate of approximately 89.5%, with advantages in gingival health and patient comfort. However, concerns remain regarding their long-term color stability and wear resistance. Pre-formed zirconia crowns, on the other hand, demonstrate superior strength, esthetics, and durability, with higher fracture resistance and excellent shade retention. Nevertheless, they require significant tooth reduction, which may not always be ideal for pediatric patients. CAD/CAM zirconia crowns offer the most precise marginal fit and customization, leading to high retention rates and esthetic outcomes, but their cost and time-consuming fabrication limit their widespread application. CAD/CAM crowns offer superior precision, customization, esthetics and longevity compared to preformed zirconia crowns and Bioflx crowns. Unlike preformed zirconia crowns, which come in standard sizes requiring adjustments, CAD/CAM crowns are digitally designed for an exact fit, enhancing patient comfort and reducing chairside modifications. Bioflx crowns, though flexible lack the precision of CAD/CAM restorations.

Esthetically, CAD/CAM crowns provide better shade matching and translucency, closely

resembling natural teeth. Preformed zirconia crowns often lack translucency, and Bioflx crowns may not achieve the same luster. In terms of strength, CAD/CAM materials like lithium disilicate and multilayered zirconia offer superior durability compared to monolithic zirconia and polymer-based Bioflx crowns. CAD/CAM crowns also ensure excellent marginal adaptation, minimizing microleakage and secondary caries risk. Their digital workflow eliminates traditional impressions, reducing patient discomfort and improving efficiency.

While each crown type has demonstrated clinical success, the choice should be based on individual patient needs and clinical circumstances. Further longitudinal studies are needed to establish the long-term performance of Bioflx crowns and optimize their material properties for improved longevity. Ultimately, the selection of an appropriate full-coverage restoration should be durable, esthetics, ease of placement, and patient satisfaction to ensure the best outcomes in pediatric dental care.

SUMMARY AND CONCLUSION

This randomized controlled trial assessed multiple clinical parameters, including retention, marginal integrity, occlusal wear, esthetic acceptability and overall functional longevity over a defined follow-up period. The primary objective was to determine the most effective restorative option for endodontically treated primary molars based on their clinical performance, longevity, and biocompatibility.

The study findings revealed that CAD/CAM zirconia crowns and Pre-formed zirconia crowns exhibited excellent fracture resistance and retention, owing to their monolithic structure and high flexural strength. These crowns demonstrated superior durability, making them an ideal choice for cases where high masticatory forces are expected. However, they required significant tooth reduction. CAD/CAM zirconia crowns, provided superior marginal adaptation and anatomical accuracy. The customized fit of these crowns enhanced occlusal harmony, reduced plaque accumulation, and minimized the chances of secondary caries. Additionally, their excellent esthetic properties made them a preferable choice for parents and children concerned about appearance. However, the increased laboratory time and cost associated with CAD/CAM fabrication were noted as potential drawbacks.

Preformed resin polymer (Bioflx) Crowns, a newer polymer-based alternative, demonstrated promising periodontal compatibility and ease of chairside adaptation. Their flexibility allowed for a more conservative tooth preparation, preserving more natural tooth structure. Additionally, it provided a favorable biological response to gingival health. However, concerns were raised regarding their long-term wear resistance and susceptibility to occlusal forces. These crowns were more prone to deformation under heavy mastication compared to their zirconia counterparts.

Pre-formed zirconia crowns and CAD/CAM zirconia crowns exhibited relatively lower gingival inflammation scores due to their highly polished surfaces, which reduced plaque retention. CAD/CAM zirconia crowns having high retention rates due to their precise fit and strong adhesive bonding than Pre-formed Zirconia Crowns. Bioflx Crowns exhibited moderate retention capabilities but required additional precautions in high-stress areas to prevent dislodgment.

Thus, all three types of crowns—Pre-formed zirconia crowns, CAD/CAM zirconia crowns, and Bioflx crowns—proved to be clinically acceptable options for the restoration of endodontically treated primary molars. Each type of crown exhibited unique advantages and limitations that should be considered when selecting the most appropriate restorative option.

Future research should also focus on improving the material properties of pre formed resin polymer crowns to enhance their longevity and resistance to occlusal wear.

LIMITATION OF THE STUDY

- **Short Follow-up Period** – The study was conducted over a limited timeframe, which may not fully capture the long-term success, wear resistance, or failure rates of the crowns. A longer follow-up is needed to assess durability and longevity more accurately.

- **Limited Sample Size** – A relatively small sample size may limit the generalizability of the findings. A larger cohort would provide more statistically significant results and better represent diverse clinical scenarios.

- **Patient Compliance** – The success of any dental restoration depends on oral hygiene maintenance. Differences in patient compliance with oral hygiene instructions could have influenced gingival health and plaque accumulation, affecting study results.

- **Material-Specific Limitations** – Each crown type has its own inherent limitations. Bioflx Crowns showed potential deformation under occlusal forces, while CAD/CAM Zirconia Crowns required additional laboratory time, increasing treatment costs. These material-specific drawbacks should be considered when interpreting results.

- **Lack of In-depth Cost Analysis** – While the study assessed clinical performance, it did not extensively analyze the cost-effectiveness of each crown type. Financial considerations play a significant role in treatment decisions, especially in pediatric dentistry.

SCOPE OF THE STUDY

The Pre-formed Bioflx crowns are new to Indian market and can change scenario of pediatric dentistry as they are formed by high strength resin polymer used in the medical device industry in applications requiring high strength, flexibility and durability and cost effective. Bis-GMA is absent in these crowns.

Bis-GMA contains Bisphenol A which is linked to have harmful effect on brain and increase risk of cardiovascular disease.

No BisGMA in Bio-flx makes them safe for the growing child's mental health

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ANNEXURES

ANNEXURE I

ETHICAL COMMITTEE APPROVAL FORM

SANTOSH
Deemed to be University
(Established u/s 3 of the UGC Act, 1956)

F. No. SU/2023/2480[12] Dated: 26.09.2023

Subject: Grant of Ethical Clearance for Thesis Protocol Topic "A Randomised controlled trial to evaluate clinical performance of Preformed zirconia crowns,CAD/CAM, zirconia crown and Preformed resin polymer crown in primary molars post endodontic therapy.", submitted by **Dr. RISHABH SOLANKI,** MDS student of Batch 2022-2023, Department of **PEADIATRIC & PREVENTIVE DENTISTRY**.

*****

With reference to his/her request for grant of Ethical Clearance for the Thesis Protocol entitled "A Randomised controlled trial to evaluate clinical performance of Preformed zirconia crowns,CAD/CAM, zirconia crown and Preformed resin polymer crown in primary molars post endodontic therapy.", **Dr. RISHABH SOLANKI** is informed that the Thesis Protocol submitted by him/her was considered by the **Screening Committee** of the Santosh Dental College & Hospital in its meetings held on 07.02.2023 & 08.02.2023. The recommendations of the **Screening Committee** were considered in detail by the Institutional **Ethics Committee** in its meeting held on **23.09.2023** and the same was **approved** by the **Ethics Committee**.

He /She is informed accordingly for further necessary action.

[DR. NARESH SHARMA]
REGISTRAR

SANTOSH "DEEMED TO BE UNIVERSITY" REGISTRAR GHAZIABAD, NCR (UP)

Dr. RISHABH SOLANKI
MDS student of batch 2022-2023
Department of PEADIATRIC & PREVENTIVE DENTISTRY
Email: rsolanki9313@gmail.com

Copy to:
1. The Vice Chancellor
2. The Dean, SDC&H
3. The Dean – Research
4. The Dean – Academics
5. The Director - IQAC
6. **Dr. Nidhi Gupta** (Guide)
7. HOD of **PEADIATRIC & PREVENTIVE DENTISTRY**

ANNEXURE II

CONSENT FORM

SANTOSH
Deemed to be University
(Established u/s 3 of the UGC Act, 1956)

INFORMED CONSENT

DEPARTMENT OF PEDIATRIC AND PREVENTVE DENTISTRY

SANTOSH DENTAL COLLEGE AND HOSPITAL, GHAZIABAD

I, Mr. / Mrs ……..
Mother/ Father of. ……..
Resident of ……..

have been informed about all the benefits and risks during and after my child dental procedure. I am willing for my child to participate in the study conducted by the department of Pediatric and Preventive Dentistry, Santosh Dental College and Hospital. I should choose to withdraw my child from this study at any point; I will be free to do so after giving prior information to the concerned surgeon.

Signature of Surgeon In-charge

Date:

Signature of Parent/Guardian

Date:

ANNEXURE III

संतोष डेंटल कॉलेज

सूचित सहमति पत्र

बाल एवं निवारक दंत चिकित्सा विभाग

मैं, श्री / श्रीमती .....पिता / माता .....निवासी.....

.....को मेरे बच्चे की दंत चिकित्सा प्रक्रिया के दौरान और बाद में होने वाले सभी लाभों और जोखिमों की जानकारी दी गई है।

मैं अपनी स्वेच्छा से अपने बच्चे को संतोष डेंटल कॉलेज और अस्पताल, गाज़ियाबाद के बाल एवं निवारक दंत चिकित्सा विभाग द्वारा संचालित अध्ययन में भाग लेने के लिए अनुमति देता/देती हूँ।

यदि मैं कभी भी अपने बच्चे को इस अध्ययन से बाहर निकालना चाहूँ, तो मैं संबंधित चिकित्सक को पूर्व सूचना देकर ऐसा करने के लिए स्वतंत्र हूँ।

प्रभारी चिकित्सक के हस्ताक्षर: _____
दिनांक: _____

ANNEXURE IV

CASE RECORD PERFORMA

Follow Up Case Record Performa
2nd Primary Molar Crown Evaluation
USPHS Criteria

OPD No.:- **Date:-**

Patient Name:- **Gender/Age:-**

Address:- **Phone no.:-**

Baseline Assessment	**Parameters**	**Colour Matching**	**Gingival Health**	**Marginal Adaptation**	**Decementation**
	Alpha				
	Bravo				
	Charlie				
3 Months	**Parameters**	**Colour Matching**	**Gingival Health**	**Marginal Adaptation**	**Decementation**
	Alpha				
	Bravo				
	Charlie				
6 Months	**Parameters**	**Colour Matching**	**Gingival Health**	**Marginal Adaptation**	**Decementation**
	Alpha				
	Bravo				
	Charlie				
9 Months	**Parameters**	**Colour Matching**	**Gingival Health**	**Marginal Adaptation**	**Decementation**
	Alpha				
	Bravo				
	Charlie				
12 Months	**Parameters**	**Colour Matching**	**Gingival Health**	**Marginal Adaptation**	**Decementation**
	Alpha				
	Bravo				
	Charlie				

ANNEXURE V

PARENTAL SATISFACTION

Department of Pediatric and Preventive Dentistry

OPD No.:- **Date:-**

Patient Name:- **Gender/Age:-**

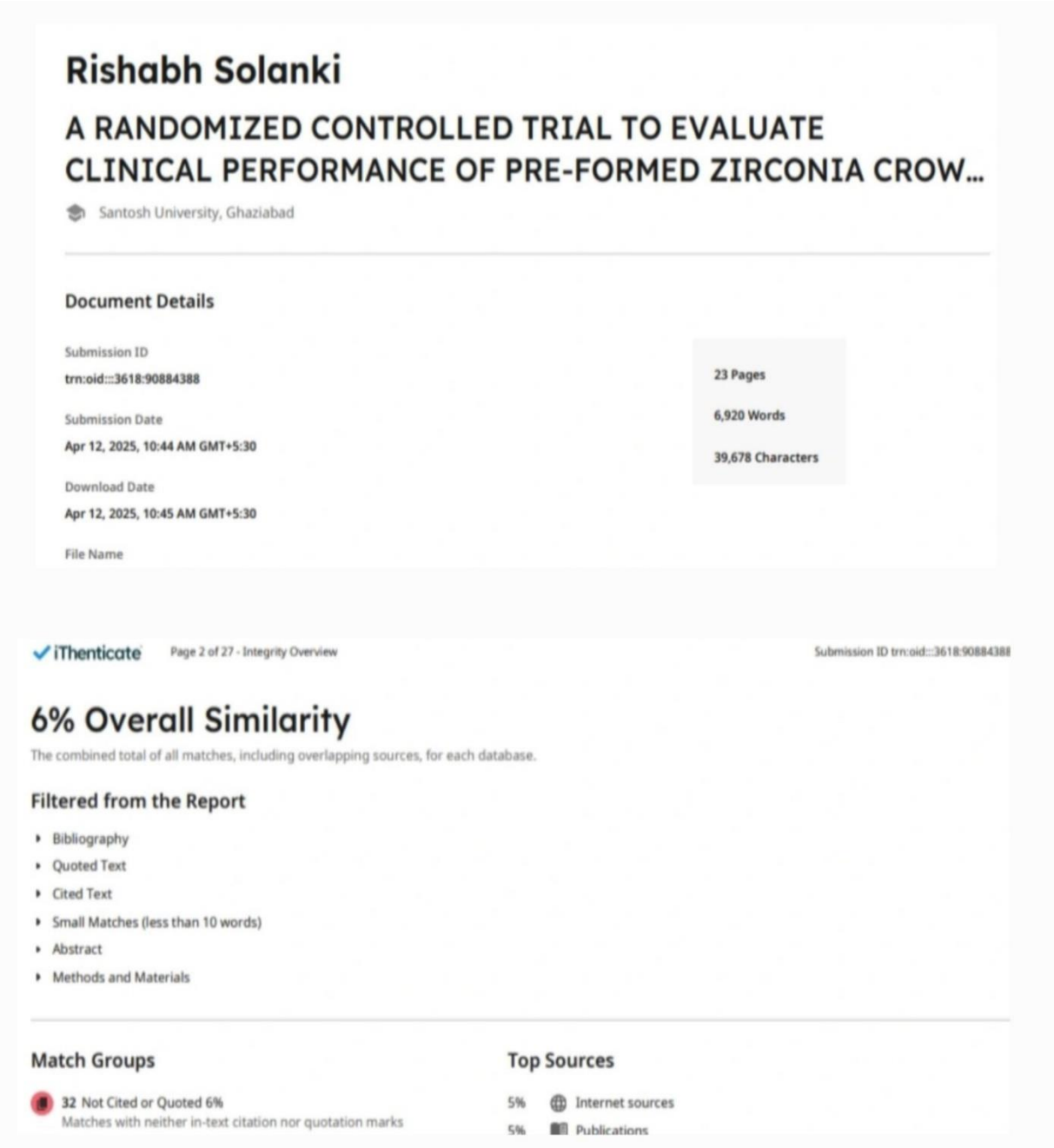
Address:- **Phone no.:-**

Likert's Chart for Parental Satisfaction

Questions	5 Strongly Disagree	4 Disagree	3 Undecided	2 Agree	1 Strongly Agree
Q1. Are you happy with the colour of the tooth?					
Q2. Is the size of crown accurate?					
Q3. Any discomfort experienced during the treatment?					
Q4. Any discomfort to child in chewing?					
Q5. Was the Shape of crown good?					

ANNEXURE VI

ANTI PLAGIARISM REPORT



Rishabh Solanki

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